12. Aquatic Biological Resources

12.1 Introduction

This chapter describes the aquatic habitat and fish resources found within the Extended, Secondary, and Primary study areas. Descriptions and maps of these three study areas are provided in Chapter 1 Introduction. Fish species of primary management concern include special-status species and species that have substantial commercial or recreation value. The biology and life history of these species are described in Appendix 12A.

The regulatory setting for aquatic biological resources is discussed briefly in this chapter, and is presented in greater detail in Chapter 4 Environmental Compliance and Permit Summary.

This chapter focuses primarily on the Primary Study Area. Potential impacts in the Secondary and Extended study areas are evaluated and discussed qualitatively. Potential local and regional impacts from constructing, operating, and maintaining the alternatives are described and compared to applicable significance thresholds. Mitigation measures are provided for identified significant or potentially significant impacts, where appropriate.

12.2 Environmental Setting/Affected Environment

12.2.1 Extended Study Area

12.2.1.1 Methodology

A county-level California Natural Diversity Database (CNDDB) (CDFG, 2009) search was conducted to determine the special-status fish species that may occur within the 39 counties included in the Extended Study Area. Documents specific to areas and species within the Extended Study Area were also reviewed to characterize aquatic biological resources.

12.2.1.2 Level 4 National Wildlife Refuges and Wildlife Areas

In addition to providing irrigation water to the Sacramento and San Joaquin valleys, and domestic water to cities and industries in Sacramento County and the east and south Bay areas, the CVP supplies water to wildlife refuges.

Fish species occur in the waterways that deliver CVP Level 4 wildlife refuge water supply[1] to the wetlands within the wildlife refuges. In the Sacramento River Basin, the refuges that receive Level 4 water include the Sacramento and Delevan national wildlife refuges (NWR). Waterways within these refuges include creeks, the Colusa Basin Drain (CBD), and many smaller water supply and drainage ditches. These waterways are part of the Sacramento River system. Most resident fish in the waterways that supply the refuge system are non-native warm-water species. Native anadromous fish include steelhead and four distinct runs of Chinook salmon.

[1] The Level 4 water deliveries that could be affected by Project operation are contracted to The Sacramento and Delevan National Wildlife Refuges (NWR), the West Bear Creek unit of the San Luis NWR Complex and the Merced unit of the Merced NWR, as well as the Los Banos, Volta, and Mendota WAs, the China Island and Salt Slough units of the North Grasslands Wildlife Area, and private wetlands of the Grassland Resource Conservation District within the San Joaquin River Basin; and to the Kern and Pixley NWRs within the Tulare Lake Basin.

The waterways of the NWRs and Wildlife Areas (WAs) within the San Joaquin River Basin and Tulare Lake Basin that receive Level 4 water supply support warm-water resident fish species. Sensitive species are not known to occur within the San Joaquin River Basin and the Tulare Lake Basin NWRs and WAs within the Extended Study Area (Reclamation et al., 2001; USFWS, 2004). Fish species commonly found in the San Joaquin River Basin NWR water conveyance ditches and canals include spotted bass (*Micropterus punctulatus*), largemouth bass (*M. salmoides*), channel catfish (*Ictalurus punctatus*), sunfish (*Lepomis* sp.), brown bullhead (*Ameiurus nebulosus*), and common carp (*Cuprinus carpio*). Flooding may occur, but is much less frequent than in the Sacramento River Basin. Sacramento splittail *(Pogonichthys macrolepidotus*) may occur within the San Joaquin River Basin NWRs during periods of spring flooding or high flows. Spawning populations of fall-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley Steelhead (*Onchorynchus mykiss*), and lamprey (*Lampetra* sp.) are known to occur in the San Joaquin River Basin north and downstream of the NWRs (Reclamation et al., 2001). Fish passage upstream of the Merced River confluence is limited during the fall by a fish barrier that CDFG maintains in the San Joaquin River to prevent passage of adult fall-run Chinook salmon.

The fish species of primary management concern that may occur in the Extended Study Area are listed in Table 12-1.

Table 12-1
Fish Species of Primary Management Concern in the Extended Study Area

Common Name	Scientific Name	Listing Status Federal/State[a]
Central Valley Chinook salmon, winter-run[b]	*Oncorhynchus tshawytscha*	FE/SE
Central Valley Chinook salmon, spring-run[b]	*Onchorynchus tshawytscha*	FT/ST
Central Valley Chinook salmon, fall-/late fall-run	*Onchorynchus tshawytscha*	FSC/CSSC
Central Valley steelhead[b]	*Onchorynchus mykiss*	FT
Klamath Mountain Province ESU Steelhead	*Onchorynchus mykiss*	C
Central California Coast Steelhead	*Onchorynchus mykiss*	FT
South Central California Coast Steelhead	*Onchorynchus mykiss*	FT
Southern California Steelhead	*Onchorynchus mykiss*	FE
Coho Salmon Northern California/Southern Oregon ESU[c]	*Oncorhynchus kisutch*	FT
Central California Coast Coho Salmon ESU	*Oncorhynchus kisutch*	FE
Green sturgeon Southern DPS[d, b]	*Acipenser medirostris*	FT/CSSC
White sturgeon	*Acipenser transmontanus*	None
Delta smelt[b]	*Hypomesus transpacificus*	FT/ST
River lamprey	*Lampetra ayresi*	FSC/CSSC
Pacific lamprey	*Lampetra tridentata*	None
Sacramento splittail	*Pogonichthys macrolepidotus*	FT/CSSC
Hardhead	*Mylopharodon conocephalus*	CSSC
Longfin smelt	*Spirinchus thaleichthys*	FT/CSSC
Eulachon	*Thaleichthys pacificus*	FT
Largemouth bass	*Micropterus salmoides*	None
Resident Rainbow trout	*Oncorhynchus mykiss*	None
Brown trout	*Salmo trutta*	None
American shad	*Alosa sapidissima*	None
Striped bass	*Morone saxatilis*	None

[a]Status Key

FE = Federal Endangered
FT = Federal Threatened
FSC = Federal Species of Concern
C = Federal Candidate species
SE = State Endangered
ST = State Threatened
CSSC = California Species of Special Concern

[b]Critical Habitat has been designated for this species.
[c]ESU = Evolutionarily Significant Unit
[d]DPS = Distinct Population Segments

Source: CDFG, 2009.

12.2.1.3 Export Service Area Reservoirs

The CVP and SWP reservoirs (including San Luis Reservoir) that supply the service areas within the Extended Study Area support warmwater and coldwater sport fish, such as striped bass (*Morone saxatilis*), largemouth bass, and resident rainbow trout (*Oncorhynchus mykiss*). Fish species listed as sensitive, threatened, or endangered are found downstream of the major Central Valley reservoirs and in the Sacramento-San Joaquin Delta (Delta), but do not persist in the aqueduct and other constructed water conveyance and storage facilities. The fish species of management concern that are found in the Sacramento River Watershed and Delta are discussed in more detail in Section 12.2.2. Fish species of primary management concern that occur within and downstream of the CVP and SWP export service area reservoirs of the Extended Study Area are listed in Table 12-1 (NMFS, 1999).

12.2.2 Secondary Study Area

12.2.2.1 Methodology

A county-level CNDDB (CDFG, 2009) search was conducted to determine the special-status fish species that may occur within the 22 counties of the Secondary Study Area. For fish species listed pursuant to the Federal Endangered Species Act (FESA) that could occur within the Sacramento/San Joaquin River and Delta region, the Sacramento Fish and Wildlife Office's Endangered Species Program website (USFWS, 2010) was consulted. For species listed pursuant to the California Endangered Species Act (CESA) in this region, the January 2011 Endangered and Threatened Animal List maintained by CDFG was consulted (CDFG, 2011a). Documents or data specific to areas and species within the Secondary Study Area were also reviewed to characterize aquatic biological resources.

12.2.2.2 Sacramento River Watershed

The aquatic environments associated with the Sacramento River Watershed include Shasta Lake, Keswick Reservoir, Whiskeytown Reservoir, Spring Creek, Clear Creek, and the Sacramento River downstream of Keswick Dam. The Sacramento River Watershed drains an area of approximately 27,000 square miles and is the largest watershed in California (Figure 12-1). Its headwater streams upstream of Shasta Dam include the Fall, Upper Sacramento, Pit, and McCloud rivers. The watershed also includes the Feather River and American River watersheds.

The Sacramento River Watershed supports several fish species of primary management concern (Table 12-2), including green sturgeon (*Acipenser medirostris)*, Central Valley steelhead, and winter-, spring-, fall-, and late-fall-run Chinook salmon.

Table 12-2
Fish Species of Primary Management Concern in the Sacramento River Watershed Portion of the Secondary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Central Valley Chinook salmon, winter-run[b]	Sacramento River downstream of Keswick Dam	FE/SE
Central Valley Chinook salmon, spring-run[b]	Sacramento River downstream of Keswick Dam	FT/ST
Central Valley Chinook salmon, fall/late fall-run	Sacramento River downstream of Keswick Dam	FSC/CSSC
Central Valley steelhead[b]	Sacramento River downstream of Keswick Dam	FT

Table 12-2
Fish Species of Primary Management Concern in the Sacramento River Watershed Portion of the Secondary Study Area

Green sturgeon	Sacramento River downstream of Keswick Dam	FT/CSSC
White sturgeon	Sacramento River downstream of Keswick Dam and Shasta Lake	None
River lamprey	Sacramento River downstream of Keswick Dam	FSC/CSSC
Pacific lamprey	Sacramento River downstream of Keswick Dam	None
Sacramento splittail	Sacramento River downstream of Keswick Dam	FT/CSSC
California roach	Sacramento River and Streams Throughout Study Area	CSSC
Hardhead	Sacramento River downstream of Keswick Dam	CSSC
Largemouth bass	Throughout Study Area	None
Smallmouth bass	Throughout Study Area	None
Spotted bass	Throughout Study Area	None
Landlocked Chinook salmon	Shasta Lake and Whiskeytown Lake	None
Resident rainbow trout	Throughout Study Area	None
Brown trout	Throughout Study Area	None
American shad	Sacramento River downstream of Keswick Dam	None
Striped bass	Sacramento River downstream of Keswick Dam	None

[a]**Status Key**

FE = Federal Endangered
FT = Federal Threatened
FSC = Federal Species of Concern
SE = State Endangered
ST = State Threatened
CSSC = California Species of Special Concern

[b]Critical Habitat has been designated for this species within the Secondary Study Area.

Source: CDFG, 2011a, Moyle, 2002.

Shasta Lake

Shasta Lake supports cold-water and warm-water fisheries. Thermal stratification, which occurs in Shasta Lake annually between April and November, establishes a warm surface water layer (epilimnion), a middle water layer characterized by decreasing temperature with increasing depth (metalimnion or thermocline), and a bottom cold-water layer (hypolimnion). The warm epilimnion of Shasta Lake provides habitat for warm-water fishes, whereas the reservoir's cold metalimnion and hypolimnion provides habitat for cold-water fish species throughout the summer and fall. Hence, Shasta Lake supports a "two-story" fishery during the stratified portion of the year (April through November).

Cold-water species in Shasta Lake include rainbow trout, brown trout (*Salmo trutta*), landlocked white sturgeon, and landlocked Chinook salmon. The lake's rainbow trout and Chinook salmon fishery are sustained through stocking of hatchery-raised fish. Shasta Lake warm-water species include smallmouth bass (*Micropterus dolomieu*), largemouth bass, spotted bass, black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), and brown bullhead (*Ameiurus nebulosus*). Non-game species in Shasta Lake include golden shiner (*Notemigonus crysoleucas*), threadfin shad (*Dorosoma petenense*), common carp, Sacramento sucker (*Catostomus occidentalis*), and Sacramento pikeminnow (*Ptychocheilus*

grandis). The rainbow trout, Chinook salmon, smallmouth, largemouth, and spotted bass fisheries are important sport fisheries in the area.

Although developed primarily for irrigation, the multiple-purpose Shasta Lake also provides flood control, improves Sacramento River navigation, supplies domestic and industrial water, generates hydropower, provides fish and wildlife habitat, creates opportunities for recreation, and enhances water quality. Since construction, Shasta Dam has played a major role in meeting Bay-Delta water quality standards, and meeting temperature and spawning habitat requirements for the endangered winter-run Chinook salmon (Reclamation, 1999a). These uses of Shasta Lake water cause water surface elevations to fluctuate by approximately 55 feet over the course of a year, which disturbs the reservoir's littoral (shallow, nearshore) habitats and influences the availability of cold- and warmwater habitats in the lake. Disruptions to littoral habitat also occur from shoreline wave action caused by wind and boating activity (Reclamation et. al., 2003). Littoral habitat supports spawning and rearing habitat for warm-water fish that are important for the sport fishery. These fish include smallmouth, largemouth, and spotted bass; black crappie; bluegill; and green sunfish. These fish species spawn in the spring between March and June. Surface water fluctuations during spring can dewater nests and reduce the amount of overhanging, emergent, and submerged vegetative cover, which can reduce the abundance of these fish species (DWR, 2002).

Keswick Reservoir

Cold-water fish species found in Keswick Reservoir include resident rainbow trout and brown trout. Warm-water species include the same species found in Shasta Lake. CDFG occasionally plants hatchery-reared fish in Keswick Reservoir. The reservoir is accessible from shore and by boat, but it is not heavily used for fishing. Keswick Dam is the uppermost barrier to anadromous fish migrating up the Sacramento River. Because of its small size, Keswick Reservoir does not stratify. Reservoir levels fluctuate daily by one to three feet. The reservoir can fluctuate as much as eight to nine feet on an annual basis. Releases to the Sacramento River have ranged from approximately 3,300 cfs (DWR, 2011) during drought periods and 79,000 cfs during flood events (DWR, 1974).

Whiskeytown Lake

Whiskeytown Lake supports cold-water and warm-water fisheries. Cold-water fish species include rainbow trout, brown trout, landlocked Chinook salmon, and kokanee salmon (*Oncorhynchus nerka*). The lake is well known for its kokanee salmon sport fishery. CDFG plants kokanee in Whiskeytown Lake, but kokanee also spawn in tributaries, such as Brandy and Whiskeytown creeks upstream of the reservoir. Warm-water fish species include largemouth bass, crappie, green sunfish, and various species of catfish.

The cold-water pool in Whiskeytown Lake is managed to provide cold water for release to the Sacramento River and Clear Creek. Temperature control curtains are operated on Whiskeytown Lake and on Lewiston Reservoir to improve the amount of cold-water pool available for release to the Sacramento River for winter-run Chinook salmon. The Whiskeytown Lake curtains are located at the Judge Francis Carr Powerhouse outlet and at the Spring Creek Tunnel inlet. The Carr Powerhouse curtain prevents the mixing of cold Trinity River water with warm surface water and directs it to the reservoir's deep cold-water layer. The Spring Creek Tunnel curtain prevents the diversion of warm surface water while allowing the diversion of cold water from the reservoir's bottom layer. Similar to Shasta Lake, fluctuations in surface water elevations disturb littoral habitat and warm-water fish species important to the sport fishery.

Sacramento River Downstream of Keswick Dam

The Sacramento River supports many resident and anadromous fish (Table 12-2). The Sacramento River supports a wide range of aquatic habitats, from fast-flowing gravel bedded reaches with alternating riffles and pools, to slow-moving off-channel sloughs and oxbows with fine sediments. From Keswick Dam to the City of Red Bluff, the river is relatively narrow and deep with some areas of broader alluvial floodplain. Most of the Chinook salmon spawning habitat in the Sacramento River is located in this reach.

Between the cities of Red Bluff and Colusa, the river meanders over a broad alluvial floodplain, and flow is significantly affected by tributaries during winter storms. From Colusa to the City of Sacramento, the river is constrained by levees. In this reach, high winter flows spill from the river into a system of weirs and bypasses, including the Sutter Bypass and Yolo Bypass. These bypasses can supply important floodplain rearing habitat for outmigrating Chinook salmon from the Sacramento River and its tributaries.

The variability and magnitude of natural seasonal flows on the Sacramento River have been significantly altered for the purposes of irrigation and flood control. The dams and diversions operated by the CVP and local irrigation districts control much of the flow in the Sacramento River. These dams and diversions include the Shasta, Keswick, Trinity, Lewiston, Whiskeytown, and Spring Creek Debris dams, the Anderson-Cottonwood Irrigation District diversion dam and canal, the Red Bluff Diversion Dam (RBDD), the Glenn-Colusa Irrigation District (GCID) pumping plant and canal, and the Tehama-Colusa (T-C) and Corning canals. Shasta Dam has the largest impact on Sacramento River flow. In addition to altering flows, the dam has substantially reduced the quality and availability of habitat for migratory and resident fish species by blocking passage, and reducing the delivery of coarse sediment and large wood debris. The effects of Shasta Dam on spawning habitat quality and flow are especially evident in the Redding area. Downstream of Redding, the tributaries to the Sacramento River, such as Cow Creek and Cottonwood Creek, influence flow and sediment supply and reduce the impacts of Shasta Dam on channel and floodplain habitat.

To protect holding and spawning winter-run Chinook salmon, Reclamation has been required to manage cold-water reservoir storage and releases to maintain daily average water temperatures at or below 56ºF between Keswick Dam and compliance locations between Balls Ferry and Bend Bridge from May 15 to September 30 since 1993. Cold-water releases from Shasta Dam mitigate for loss of habitat up-stream of Shasta Dam, by providing cooler water temperatures in the upper reaches of the river that are still accessible to anadromous fish. In drier years, when reservoir storage is low, the stretch of river in which cold-water temperatures are maintained is shortened by approximately nine miles, ending at Jelly's Ferry Bridge. Water temperature control was improved in 1997 with the installation of the temperature control device at Shasta Dam. The device allowed greater control over cold-water reserves in Shasta Lake while continuing hydroelectric power generation. Before its installation, Reclamation had to forego power generation to make cold-water releases, especially during periods of low reservoir levels. Figure 12-2 shows average daily water temperatures at points along the Sacramento River from Balls Ferry to Colusa.

To mitigate for the loss of coarse sediment, Reclamation has managed an ongoing gravel augmentation program since 1997 on the Sacramento River, pursuant to the Central Valley Project Improvement Act (CVPIA), to improve Chinook salmon and steelhead spawning habitat in the Redding area upstream of Turtle Bay (RM 299). Prior to Shasta Dam, DWR estimates that the amount of gravel delivered to the river from the watershed above Shasta Dam was approximately 120,000 tons (75,000 cubic yards) per year (DWR, 1980).

A total of 174,670 tons (106,500 cubic yards) of gravel was added to the river by Reclamation, DWR, and CDFG between 1978 and 2005 (North State Resources, 2010). Reclamation continued this effort by adding a total of 54,000 tons of gravel to the river immediately downstream of Keswick Dam from 2006 through 2012(Hannon, pers. comm., 2012). Large in-channel gravel mining pits, which were created when gravel was mined for the construction of Shasta Dam, trap the gravel as it is transported downstream, limiting the amount of spawning habitat that is enhanced and reducing the time the gravel functions as spawning habitat. The gravel is placed upstream of these pits to enhance spawning habitat for winter-run Chinook salmon, which spawn primarily between Keswick Dam and Turtle Bay. Cottonwood Creek supplies an annual average of 65,000 tons of gravel to the Sacramento River, and as a result, the sediment conditions for spawning habitat improve and the effects from Shasta Dam are diminished at the confluence (RM 273) (DWR, 1994).

Blocked access to historical spawning grounds in the upper watershed causes spring-run Chinook salmon to spawn in the same lowland reaches of the Sacramento River that fall-run Chinook salmon use as spawning habitat. The overlap in spawning sites, combined with a slight overlap in spawning timing (Moyle, 2002), may be responsible for inter-breeding between spring and fall-run Chinook salmon. This inter-breeding has been observed in the Feather River (Hedgecock et al., 2001). Since 2008, very few spring-run spawned in the mainstem of the Sacramento River (CDFG, 2011b).

Diversions on the Sacramento River Downstream of Keswick Dam

Of the approximately 424 water diversions on the Sacramento River between Keswick Dam and the City of Sacramento at the I Street Bridge, approximately six percent have fish screens. Most of the diversions occur between the City of Colusa and the City of Sacramento. Diversions that are of significance to the aquatic environment and the proposed Project are the RBDD and the GCID Pumping Plant.

Diversions from the RBDD are made to the T-C and Corning canals at a maximum rate of approximately 2,500 cfs and a maximum annual diversion of about 600,000 acre-feet (TCCA and Reclamation, 2002). Closure of the RBDD gates affects passage of green sturgeon, steelhead, and winter-, spring- and fall-run Chinook salmon. Because of these concerns, the RBDD gates have been closed only from May 15 through September 15, and from June 15 to August 31 since 2009. The new period of gate closure is required in the June 2009 NMFS Operations Criteria and Plan Biological Opinion (NMFS, 2009). Although the gates are open at the beginning and end of the irrigation season, diversions are limited to what is available through pumps that have been installed at the headworks. The Tehama-Colusa Canal Authority (TCCA) constructed an interim pumping plant in 2009 to meet irrigation demands when the diversion dam gates are out. A new pumping plant and fish screen was constructed upstream of RBDD to replace the dam and improve passage for Chinook salmon, steelhead, and green sturgeon. Construction was completed in September 2012. The screen design allows diversion of up to 2500 cfs. The pumping plant has a diversion rate of 2,000 cfs and can be expanded to a rate of 2,500 cfs (Reclamation, 2009).

The GCID Pumping Plant provides water for primarily agricultural irrigation, but also supplies water for rice straw decomposition in the fall and maintenance of waterfowl habitat. The pumping plant is located on an oxbow channel west of the main Sacramento River channel. An interim flat plate fish screen was installed to replace a drum screen structure in 1993 to enhance fish protection at the pumping plant, and a permanent flat plate screen was installed in 2000. The flat plate screen has improved the protection for larval and juvenile anadromous fish at the GCID pumping plant, but investigations and monitoring have indicated that mortality caused by pumping operations is exceeding performance criteria for the facility. Mortality may be the result of predation in the oxbow channel.

To maintain appropriate sweeping and approach velocities at the screen, a "gradient facility" was constructed in the main channel of the Sacramento River upstream of the oxbow. Factors related to the GCID pumping plant and fish screen affecting juvenile fish are the approach and sweeping velocities, bypass position, and potential predations throughout the facility (Vogel, 2005).

Yolo Bypass and Sutter Bypass

Flow from the Sacramento River spills into the Sutter and Yolo bypasses during high flow events. The bypasses form a floodplain corridor that is an important part of the flood control system, but also serves an important floodplain function for juvenile salmonids and other native fish. Fish enter the bypasses through flood relief structures and weirs. The Sacramento River enters the Sutter Bypass at Moulton, Colusa, and Tisdale weirs, and enters the Yolo Bypass at the Freemont Weir. Downstream of the Freemont Weir, Cache Creek and Putah Creek enter the Yolo Bypass. Table 12-3 shows the approximate flow at which the flood relief structures are overtopped and the Sacramento River begins to flood the bypasses.

Table 12-3
Sacramento River flood relief structures and flood control weirs, and approximate flow at which water begins to enter the Sutter Bypass and Yolo Bypass.

Sacramento River Flood Relief Structure and Flood Control Weirs	Approximate Sacramento River Flow at which Structure is Overtopped (cfs)	Adjoining Basin or Bypass
Moulton Weir	65,000	Sutter Bypass
Colusa Weir	37,000	Sutter Bypass
Tisdale Weir	23,000	Sutter Bypass
Fremont Weir	56,000	Yolo Bypass

Note:
cfs = cubic feet per second

Source: NWS, 2011.

The floodplains of the bypasses are very important to rearing Chinook salmon (Sommer et al., 2001a). These areas can be much more productive than the main channel and provide a safe haven from predatory fish (Swenson et al., 2001; Sommer et al., 2001a). It remains unclear whether these spatial differences in feeding and growth result in improved survival. The use of low gradient floodplains does subject juveniles to stranding when high flows subside quickly (NMFS, 1997).

Splittail use floodplains and other shallow areas with emergent vegetation for spawning and rearing. Splittail spawning habitat is greatly increased during periods of floodplain inundation in the Sacramento and San Joaquin basins (Baxter, 1999b).

12.2.2.3 Feather River Watershed

The aquatic environments associated with the Feather River Watershed (Figure 12-3) within the Secondary Study Area include DWR's Oroville facilities (Lake Oroville, Thermalito Diversion Pool, Thermalito Forebay, Thermalito Afterbay, the fish barrier pool, and the Feather River). Issuance of the FERC license for the Oroville facilities is pending as of June 2012. The new license's requirements will affect aquatic habitat associated with and affected by the Oroville facilities, including the Feather River downstream of Oroville Dam.

Fish species of primary management concern found in the Feather River Watershed portion of the Secondary Study Area are shown in Table 12-4. The following information provided for the SWP Oroville Facilities and the Feather River is from DWR's *May 2007 Oroville Facilities Relicensing FERC Project No. 2100 Draft Environmental Impact Report*, unless otherwise noted.

Table 12-4
Fish Species of Primary Management Concern in the Feather River Watershed Portion of the Secondary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Central Valley Chinook salmon, spring-run[b]	Feather River downstream of Fish Barrier Dam	FT/CT
Central Valley Chinook salmon, fall- run	Feather River downstream of Fish Barrier Dam	FSC/CSSC
Central Valley steelhead[b]	Feather River downstream of Fish Barrier Dam	FT
Green sturgeon	Feather River downstream of Fish Barrier Dam	FT/CSSC
White sturgeon	Feather River downstream of Fish Barrier Dam	None
River lamprey	Feather River downstream of Fish Barrier Dam	FSC/CSSC
Pacific lamprey	Feather River downstream of Fish Barrier Dam	None
California roach	Feather River and Streams Throughout Study Area	CSSC
Sacramento splittail	Feather River below Fish Barrier Dam	FT/CSSC
Hardhead	Feather River downstream of Fish Barrier Dam	CSSC
Largemouth bass	Oroville Lake, Thermalito Forebay and Afterbay, Feather River downstream of Fish Barrier Dam	None
Smallmouth bass	Oroville Lake, Thermalito Forebay and Afterbay, Feather River downstream of Fish Barrier Dam	None
Spotted bass	Oroville Lake, Thermalito Forebay and Afterbay, Feather River downstream of Fish Barrier Dam	None
Rainbow trout	Lake Oroville, Diversion Pool, Thermalito Forebay	None
Brown trout	Lake Oroville, Diversion Pool, Thermalito Forebay	None
Landlocked Coho salmon	Lake Oroville	None
American shad	Feather River downstream of Fish Barrier Dam	None
Striped bass	Feather River downstream of Fish Barrier Dam	None

[a]Status designations:

FT = federally-listed as Threatened
FSC = federally-listed as Species of Concern
CT = California-listed as Threatened
CSSC = California-listed as Species of Special Concern

[b]Critical Habitat has been designated for this species within the study area.

Source: CDFG 2011a, Moyle 2002.

Lake Oroville

Lake Oroville typically thermally stratifies into three layers (epilimnion, metalimnion, and hypolimnion) beginning in the spring. The lake begins to de-stratify in the fall, and remains relatively uniform throughout the winter. Because of this stratification regime, Lake Oroville supports both cold-water and warm-water fisheries. The cold-water fish use the deeper cooler well-oxygenated hypolimnion, whereas the warm-water fish are found in the warmer shallower epilimnion and near-shore littoral zone. Once Lake Oroville de-stratifies in the fall, the two fishery components mix in their habitat use.

Oroville Dam is operated for water supply, power generation, flood control, and fish and wildlife habitat. Management for these uses causes fluctuations in surface water elevation and storage throughout the year, which affects the availability of cold- and warm-water habitat within layers. Cold-water hatchery-raised fish are stocked in Lake Oroville as yearlings, with the intent that they will grow in the lake before being caught by anglers. Hatchery stocking is necessary to sustain the cold-water fishery. Natural recruitment to the Lake Oroville cold-water fishery is very low because of a lack of spawning and rearing habitat in the reservoir and accessible tributaries, and natural and artificial barriers to migration into tributaries with sufficient spawning and rearing habitat. From 1993 through 2000, Chinook salmon and brown trout were the only salmonid species stocked in the lake. At the recommendations of CDFG, DWR began stocking Coho salmon instead of Chinook salmon and brown trout in 2002 to address an outbreak of Infectious Hematopoetic Necrosis (IHN) at the Feather River Hatchery (Coho salmon are less susceptible to IHN).

Cold water is taken from Lake Oroville's hypolimnion for releases to the Feather River for Chinook salmon and steelhead. Cold-water releases to the Feather River potentially limit the amount of cold water available for salmonids in Lake Oroville.

The Lake Oroville warm-water fishery is self-sustaining. Black bass are the most popular and important fishery, in terms of both popularity with anglers and economic effect on the area. Spotted bass are the most abundant bass species in Lake Oroville, followed by largemouth bass, redeye bass (*Micropterus coosae*), and smallmouth bass. Catfish are the next most popular warm-water sport fish sought by anglers at Lake Oroville; both channel and white catfish inhabit the lake. White and black crappie are also found in Lake Oroville; populations fluctuate widely from year to year. Bluegill and green sunfish are the most abundant sunfish species in Lake Oroville, and redear sunfish (*Lepomis microlophus*) and warmouth (*Lepomis gulosus*) exist in low numbers. Common carp, considered by many to be a nuisance species, are abundant in Lake Oroville. As described for Shasta Lake, fluctuations in surface water elevation affect littoral habitat, which can reduce the abundance of bass and sunfish (DWR, 2002).

The primary forage fish that occur in Lake Oroville are wakasagi (*Hypomesus nipponensis*) and threadfin shad. Threadfin shad were intentionally introduced in 1967 to provide forage for game fish, whereas wakasagi migrated down from an upstream reservoir in the mid-1970s. The population of threadfin shad has dwindled since the early 1990s, which may be a result of poor overwinter survival, or perhaps from competition with wakasagi for habitat and forage.

Thermalito Diversion Pool

The Feather River water temperature requirements create cold-water fishery habitat in the Thermalito Diversion Pool (Diversion Pool). The Diversion Pool is dominated by fish that have come out of Lake Oroville over the spillway or through the power plant, including rainbow trout, brown trout, and Coho salmon. With the exception of excess steelhead from the Feather River Hatchery, the Diversion Pool and the Thermalito Forebay (Forebay) are not stocked with fish by CDFG.

Thermalito Forebay

The Forebay provides habitat primarily for cold-water fish, although the same warm-water fish species found in Lake Oroville are believed to exist in the Forebay in low numbers (DWR, 2007).

Thermalito Afterbay

The Thermalito Afterbay (Afterbay) provides habitat for both cold-water and warm-water fish. Changes in flow rates, pumpback operation, and water surface elevations resulting from project operation affect water temperatures and the quality, quantity, and distribution of fish habitat in the Afterbay.

Fish species observed in the Afterbay include largemouth bass, smallmouth bass, rainbow trout, brown trout, bluegill, redear sunfish, black crappie, channel catfish, common carp, and large schools of wakasagi. Salmonids are not regularly stocked in the Afterbay, however, some years, when the Feather River Fish Hatchery has surplus steelhead (e.g., 2005, 2011, and 2012), they are put in the Afterbay. It is unlikely that any salmonids spawn in tributaries of Thermalito Afterbay. Therefore, rainbow trout and brown trout that occur in the Afterbay likely passed through the Thermalito pumping-generating plant from the Forebay. The Afterbay likely provides good habitat for largemouth, smallmouth, and spotted bass species, and large schools of wakasagi provide a good source of forage fish. Bass nest dewatering from reservoir fluctuations likely limits juvenile recruitment in the Afterbay (DWR, 2004a).

Feather River Downstream of Oroville Dam

Oroville facilities releases are primarily managed to benefit cold-water fisheries. There are several fish species of primary management concern in the Feather River downstream of Oroville Dam (Table 12-4, above), including spring- and fall-run Chinook salmon, Central Valley steelhead, and green sturgeon. The fish barrier weir at the Feather River Fish Hatchery is the most upstream barrier to fish passage on the Feather River downstream of Oroville Dam. The hatchery was constructed to mitigate for the loss of Chinook salmon and steelhead habitat upstream of Oroville Dam.

The Feather River below Oroville Dam, commences at the Low Flow Channel (LFC), which extends eight miles from the Fish Barrier Dam (RM 67) to the Thermalito Afterbay Outlet (RM 59). The LFC of the Feather River conveys releases from the Thermalito Diversion Dam to its confluence with the Afterbay outlet. Minimum flows and ramping criteria in the Feather River were established in an August 1983 agreement between DWR and DFG (DWR, 1983). The agreement specifies that DWR release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes. Therefore, the LFC is operated at 600 cfs all year with variations in flow occurring rarely, only during flood control releases, or in the summer to meet downstream temperature requirements for salmonids. Water temperatures tend to be coldest in the uppermost portions of the Feather River near the fish barrier dam. Upon issuance of the FERC license, higher DWR releases will likely be required to maintain lower water temperatures in the LFC.

Flows in the high flow channel of the Feather River, which conveys the combined flows from the low flow channel and the Afterbay outlet, are maintained between the minimum flow and a flow no greater than 2,500 cfs from October 15 through November 30 to prevent Chinook salmon redd dewatering during the egg incubation period (DWR, 2007). The flow regime in the reach of the Feather River extending from the Thermalito Afterbay outlet (RM 59) to the confluence of the Feather and Sacramento rivers (RM 0) varies depending on runoff and month. The instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. In Critical years, however, the minimum flow can be reduced to 1,200 cfs from October to February, and to 1,000 cfs in March (DWR, 2007). Small flow contributions from Honcut Creek and the Bear River, and larger flow contributions from the Yuba River, also influence flow in this segment. The Shanghai Bench between RM 26 and RM 25 and Sunset Pumps between RM 38 and 39 may impede sturgeon passage at lower flow ranges (DWR, 2007).

Oroville Dam, Thermalito Diversion Dam, and the fish barrier dam block gravel contribution to the Feather River. An estimated 97 percent of the sediment from the upstream watershed is trapped in Lake Oroville, resulting in sediment starvation downstream (DWR, 2007).

High flow releases from the Oroville facilities mobilize smaller substrate particle sizes. The smaller substrate sizes are not replaced by upstream gravel, resulting in a gradual coarsening of the particle size distribution of the substrate in the upper portions of the Feather River. Coarsening and armoring of the substrate size can affect the quality of spawning habitat and the distribution of spawning salmonids and other fishes. In general, the reach of river with the highest proportion of coarse substrate components is the low flow channel of the Feather River.

Blocked access to historical spawning grounds in the upper watershed causes spring-run Chinook salmon to spawn in the same lowland reaches of the Feather River as fall-run Chinook salmon. The overlap in spawning sites, combined with a slight overlap in spawning timing (Moyle, 2002) may be responsible for inter-breeding between spring-run and fall-run Chinook salmon in the Feather River (Hedgecock et al., 2001).

The majority of in-river spring-run Chinook salmon spawning is concentrated in the uppermost three miles of accessible habitat in the Feather River downstream of the Feather River Fish Hatchery, although spawning may extend to the downstream portion of the low flow channel upstream of the Thermalito Afterbay outlet (Sommer et al., 2001b).

Most of the natural steelhead spawning and rearing in the Feather River occurs in the low flow channel, particularly in the upper reaches near Hatchery Ditch, a side-channel located between RM 66 and 67 between the Table Mountain Bicycle Bridge and Lower Auditorium Riffle. Limited steelhead spawning also occurs downstream of the Thermalito Afterbay outlet. The smaller substrate size and greater amount of cover (compared to the main river channel) also make these side-channels more suitable for juvenile steelhead rearing (DWR, 2004b). This type of habitat comprises less than one percent of the available habitat in the low flow channel.

12.2.2.4 Trinity River Watershed

The aquatic environment associated with the Trinity River Watershed (Figure 12-4) within the Secondary Study Area includes Reclamation's Trinity River Division (TRD) facilities, which include Trinity Lake, Lewiston Lake, Whiskeytown Lake (which is described in the Sacramento River Watershed section), and the Trinity River downstream of Lewiston Dam.

Fish species of primary management concern found in the Trinity River Watershed portion of the Secondary Study Area are shown in Table 12-5.

Table 12-5
Fish Species of Primary Management Concern in the Trinity River Watershed Portion of the Secondary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Chinook salmon, spring-run	Trinity River downstream of Lewiston Dam	CSSC
Chinook salmon, fall- run	Trinity River downstream of Lewiston Dam	CSSC
Steelhead (Klamath Mountains Province DPS)	Trinity River downstream of Lewiston Dam, Klamath River	CSSC

Table 12-5
Fish Species of Primary Management Concern in the Trinity River Watershed Portion of the Secondary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Green sturgeon (Northern DPS)	Klamath River and Trinity River	CSSC
White sturgeon	Trinity River and Klamath River	None
River lamprey	Feather River downstream of Fish Barrier Dam, Klamath River	FSC/CSSC
Pacific lamprey	Feather River downstream of Fish Barrier Dam, Klamath River	None
Hardhead	Trinity River, Lewiston Reservoir, Trinity Lake, Klamath River	CSSC
Largemouth bass	Lewiston Reservoir, Trinity Lake	None
Smallmouth bass	Lewiston Reservoir, Trinity Lake	None
Spotted bass	Lewiston Reservoir, Trinity Lake	None
Resident rainbow trout	Trinity River, Lewiston Lake, Trinity Lake, Klamath River	None
Brown trout	Trinity River, Lewiston Lake, Trinity Lake, Klamath River	None
Coho salmon[b]	Trinity River, Lewiston Lake, Trinity Lake, Klamath River	CE, FE (Anadromous only)
American shad	Trinity River downstream of Lewiston Lake, Klamath River	None
Striped bass	Trinity River downstream of Lewiston Lake, Klamath River	None

[a]Status designations:

FE = federally-listed as endangered
FT = federally-listed as Threatened
FSC = federally-listed as Species of Concern
CE = California-listed as Endangered
CT = California-listed as Threatened
CSSC = California-listed as Species of Special Concern

[b]Critical Habitat has been designated for this species within the study area.

Note:
DPS = distinct population segment

Source: DFG 2011a, Moyle 2002.

Trinity Lake and Lewiston Lake

Releases from Trinity Lake are re-regulated in Lewiston Lake prior to release downstream into the Trinity River. Lewiston Lake also acts as a forebay for the trans-basin export of water into Whiskeytown Lake via the Clear Creek Tunnel.

TRD operation is integrated with operation of the Shasta Division of the CVP. For example, TRD exports have been made in consideration of minimum flow and temperature requirements in the Trinity and Sacramento rivers, storage levels and cold-water pool in Trinity and Shasta lakes, and other CVP operating requirements (e.g., CVP deliveries, water quality requirements, and the OCAP BO). Trinity Lake is also operated to maximize power production during the summer and fall. The majority of TRD exports occur in the spring and summer. At the same time, temperature objectives to protect Trinity River

salmon must be met. Addressing the temperature needs of the two systems is only one of the factors that influence operations.

Based on the Trinity River Mainstem Fishery Restoration ROD, dated December 19, 2000, a total of 368,600 to 815,000 AF is allocated annually for Trinity River flows. This amount is scheduled in coordination with the USFWS to best meet habitat, temperature, and sediment objectives in the Trinity River Basin (USBR, 2008).

Trinity River and Klamath River Downstream of the Trinity River

The Trinity River is the largest tributary to the Klamath River. Lewiston Dam releases are the major component of Trinity River flows until its confluence with the North Fork Trinity River. Downstream of the confluence, the accretion of tributary inflows, such as Willow Creek, reduces the dampening effects of the TRD.

The Klamath River flows from its confluence with the Trinity River to the Pacific Ocean. Species of management concern in the Trinity and Klamath rivers (Table 12-5) include Coho salmon, steelhead, spring- and fall-run Chinook salmon, and green sturgeon. The reach of the Klamath River within the Secondary Study Area is a migration route for these species to spawning habitat in the Trinity River and farther up in the Klamath River Watershed.

12.2.2.5 American River Watershed

The aquatic environments associated with the American River Watershed (Figure 12-5) within the Secondary Study Area include Folsom Lake, Lake Natoma, and the American River downstream of Nimbus Dam.

Fish species of primary management concern found in the American River Watershed portion of the Secondary Study Area are shown in Table 12-6.

Table 12-6
Fish Species of Primary Management Concern in the American River Watershed Portion of the Secondary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Central Valley Chinook salmon, fall-run	American River downstream of Nimbus Dam	FSC/CSSC
Central Valley steelhead[b]	American River downstream of Nimbus Dam	FT
Green sturgeon	American River downstream of Nimbus Dam	FT
White sturgeon	American River downstream of Nimbus Dam	None
River lamprey	American River downstream of Nimbus Dam	FSC/CSSC
Pacific lamprey	American River downstream of Nimbus Dam	None
California roach	American River and Streams Throughout Study Area	CSSC
Sacramento splittail	American River downstream of Nimbus Dam	FT/CSSC
Hardhead	Folsom Lake, Lake Natoma, American River	CSSC
Largemouth bass	Folsom Lake, Lake Natoma, American River	None
Smallmouth bass	Folsom Lake, Lake Natoma, American River	None
Spotted bass	Folsom Lake, Lake Natoma, American River	None
Rainbow trout	Folsom Lake, Lake Natoma	None

Table 12-6
Fish Species of Primary Management Concern in the American River Watershed Portion of the Secondary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Brown trout	Folsom Lake, Lake Natoma	None
American shad	American River	None
Striped bass	American River	None

[a]Status designations

FT = federally-listed as Threatened
FSC = federally-listed as Species of Concern
CT = California-listed as Threatened
CSSC = California-listed as Species of Special Concern
[b]Critical Habitat has been designated for this species within the study area.

Source: DFG 2011a, Moyle 2002.

Folsom Lake and Lake Natoma

Similar to the other large Central Valley reservoirs, strong thermal stratification occurs within Folsom Lake annually between November and April. Largemouth bass, smallmouth bass, spotted bass, bluegill, crappie, and catfish constitute the primary warm-water sport fisheries of Folsom Lake. The lake's cold-water sport species include rainbow and brown trout, kokanee salmon, and Chinook salmon, all of which are currently or have been stocked by DFG. Although brown trout are no longer stocked, a population still remains in the lake. These species are stream spawners and, therefore, do not reproduce within the lake. However, some spawning by one or more of these species may occur in the American River upstream of Folsom Lake. Other species that occur in the lake include hardhead and Sacramento pikeminnow.

Folsom Lake's cold-water pool is important not only to the lake's cold-water fish species, but also to lower American River fall-run Chinook salmon and steelhead. Seasonal releases from the lake's cold-water pool provide thermal conditions in the lower American River that support annual in-river production of these salmonid species. The cold-water pool in Folsom is primarily managed to sustain releases during October and November to maximally benefit fall-run Chinook salmon immigration, spawning, and incubation, but is not large enough to allow for cold-water releases during the warmest months (July through September) to provide maximum thermal benefits to lower American River steelhead.

Folsom Reservoir, because of its proximity to the Delta, is also often used by Reclamation to make releases when additional Delta outflow is required to meet Delta salinity standards. Consequently, Folsom Reservoir storage can be reduced, resulting in reduced cold-water pool volume. A reduced cold-water pool in Folsom Reservoir may result in releases from Nimbus Dam that are warmer and have the potential to exceed suitable water temperature ranges for fish species of focused evaluation in the American River. Nimbus Dam and Powerplant are located downstream from Folsom Dam. The dam forms Lake Natoma, which re-regulates water released from Folsom Dam and diverts water into the Folsom South Canal. Water not diverted is released into the American River through radial gates. Nimbus Dam is the most upstream barrier to fish passage on the American River.

American River Downstream of Nimbus Dam

The lower American River provides a diversity of aquatic habitats, including shallow fast-water riffles, runs, pools, and off-channel backwater habitats.

At least 40 species of fish have been reported to occur in the lower American River system, including numerous resident native and introduced species, as well as several anadromous species (SWRI, 2004).

With more than 125 miles of available upstream salmonid spawning habitat, the American River historically served as a regionally vital component for the health of fall- and spring-run Chinook salmon populations (Water Forum, 2001). Although dam construction eliminated the spring-run fishery, the lower American River continues to function as spawning and rearing habitat for large numbers of fall-run Chinook salmon. The river supports a mixed run of hatchery and naturally produced fish. During the period of 1967 through 1991 (the Anadromous Fish Restoration Program restoration goal baseline period), lower American River fall-run Chinook salmon spawning comprised on average approximately 21 percent (41,040 fish) of total fall-run Chinook salmon escapement (197,740 fish) in the Sacramento Valley river system, including the Sacramento River and its tributary rivers and creeks (DFG, 2011b). Recent escapement estimates (1992 to 2002) for the Central Valley suggest that American River fall-run Chinook salmon comprise approximately 22 percent of the total fall-run Chinook salmon escapement in the Sacramento River and its major tributaries (68,373 of 311,746) (PFMC, 2003).

The lower American River also provides spawning and rearing habitat for Central Valley steelhead. The majority of the steelhead run is believed to be of hatchery origin.

The primary factor potentially limiting fall-run Chinook salmon and steelhead production within the lower American River is believed to be high water temperatures during portions of their residency in the river. High water temperatures during the fall can delay the onset of spawning by Chinook salmon, and river water temperatures can become unsuitably high for juvenile salmon rearing during spring and for steelhead rearing during summer. In addition, relatively low October and November flows tend to increase the amount of fall-run Chinook salmon redd superimposition (occurs when females dig up the fertilized eggs of other females), thereby potentially reducing the number of juveniles produced per female.

12.2.2.6 Sacramento-San Joaquin Delta

The Delta is a unique aquatic ecosystem that provides complex habitat for a diverse assemblage of fish and macroinvertebrates. Table 12-7 identifies the fish species of primary management concern found within the Delta.

There are many fish species within the Delta that have experienced a general decline in abundance (Moyle et al., 1995). Therefore, many of these species require special management strategies, including winter-run and spring-run Chinook salmon, steelhead, delta smelt, longfin smelt, green sturgeon, and Sacramento splittail. These species are either listed for protection pursuant to FESA or CESA or listed by CDFG as a Species of Special Concern.

Several fish and macroinvertebrate species inhabiting the Delta also support recreational and commercial fisheries, such as fall-run Chinook salmon, northern anchovy, Pacific sardine, starry flounder, striped bass, largemouth bass, and white sturgeon. The Delta has been identified as Essential Fish habitat (EFH) for the commercially managed species (northern anchovy, Pacific sardine, starry flounder, and Chinook salmon) (NMFS, 2011).

USFWS and NMFS have designated all or part of the Delta within the Secondary Study Area as critical habitat or essential fish habitat for delta smelt, Central Valley steelhead, winter- and spring-run Chinook salmon, and green sturgeon.

The listing status, life history, and factors affecting population abundance for the special-status fish species that inhabit the Delta and may be affected by construction or operation of the proposed project are discussed in Appendix 12-A.

Table 12-7
Fish Species of Primary Management Concern in the Sacramento-San Joaquin Delta

Species	Scientific Name	Listing Status[a]		Life History[b]	Designated Habitat[c]
		Federal	State		
Chinook salmon (Sacramento winter-run)	Oncorhynchus tshawytscha	FE	SE	A	EFH
Chinook salmon (Sacramento spring-run)	Oncorhynchus tshawytscha	FT	ST	A	EFH
Chinook salmon (Sacramento fall/late fall-run)	Oncorhynchus tshawytscha	FSC	CSC	A	EFH
Chinook salmon (San Joaquin fall-run)	Oncorhynchus tshawytscha	FSC	CSC	R	EFH
Central Valley steelhead	Onorhynchus mykiss	FT	None	A	CH
Green sturgeon-southern DPS	Acipenser medirostris	FT	CSC		CH
Longfin smelt	Spirinchus thaleichthys	FSC	ST	A	None
Delta smelt	*Hypomesus transpacificus*	FT	ST	R	CH
Sacramento splittail	*Pogonichthys macrolepidotus*		CSC	R	None
River lamprey	Lampetra ayresii	None	CSC	A	None
Hardhead	Mylopharodon conocephalus	None	CSC	N	None
Striped bass	*Morone saxatilis*	None	None	R, A	None
Black bass	*Micropterus spp*	None	None	R	None
Sacramento perch	Archoplites inrerruptus	None	CSC	N[d]	None
Tidewater goby	Eucyclogobius newberri	FE	CSC	N	CH
Rough sculpin	Cottus asperrimus	None	ST; FP	R	None
Northern anchovy	Engraulis mordax	None	None	N	EFH
Pacific sardine	Sardinops sagax caerulea	None	None	N	EFH
Starry flounder	Platichthys stellatus	None	None	N	EFH

[a]Listing Status:
FE = Federal endangered
FT = Federal threatened
FSC = Federal species of concern
SE = State endangered
ST = State threatened
FP = State fully-protected species
CSC = State species of special concern

[b]Life History:
A = anadromous
R = resident
N = non-resident visitor

[c]Designated Habitat:
CH = Critical habitat
PCH = Proposed Critical Habitat
EFH = Essential fish habitat

[d]Essentially extirpated from the Delta

Note:
DPS = distinct population segment

Source: DFG, 2009, DFG, 2011a, Moyle, 2002, NMFS, 2011.

Many of the fish and macroinvertebrate species inhabit the Delta year-round; other species inhabit the system on a seasonal basis as a migratory corridor between upstream freshwater riverine habitat and coastal marine waters, as seasonal foraging habitat, or for reproduction and juvenile rearing habitat (Table 12-8).

The geographic distribution of fish species within the Delta is determined, in part, by salinity gradients, which range from fresh water within the Sacramento and San Joaquin river systems, to marine conditions near the Golden Gate Bridge (Moyle et-. al., 1982). The majority of fish species in the Delta use the Tidal

Perennial Aquatic community (see Affected Environment and the CALFED Ecosystem Restoration Program Plan for detailed description of the aquatic communities in the Delta).

The abundance, distribution, and habitat use by these fish and macroinvertebrates has been monitored for many years through investigations conducted by CDFG, NMFS, USFWS, DWR, and several other investigators. Results of these monitoring programs have shown evidence of long-term declines and sharper declines since the early 2000s in some of the Delta pelagic fish species (Baxter et al., 2010).

Table 12-8
Seasonal Occurrence of Different Life Stages of Migratory Fish Species of Primary Management Concern within the Sacramento-San Joaquin Delta

Species	Adult Migration (peak)	Spawning (peak)	Juvenile Freshwater Residency (all freshwater residency, not Delta residency)	Outmigration (peak)	Source
River lamprey	Fall	N/A	3-5 years	Spring	Moyle, 2002
Pacific lamprey	Jan-June (Mar-May)	N/A	5-7 years	Spring	Moyle, 2002
Green sturgeon	Feb-July	N/A	1-4 years	Aug-Oct	Federal Register, 2005; Moyle, 2002
Chinook salmon (Sacramento winter-run)	Dec-July (Mar)	N/A	5-10 months	Oct-May	Moyle, 2002; CDFG, 2010
Chinook salmon (Sacramento spring-run)	Mar-Sep (May-June)	N/A	3-15 months	Nov-Jun	Moyle, 2002; CDFG, 2010
Chinook salmon (Sacramento fall-run)	June-Dec (Sep-Oct)	N/A	1-7 months	Jan-Jun	Moyle, 2002; CDFG, 2010
Chinook salmon (Sacramento late fall-run)	Oct-Apr (Dec)	N/A	7-13 months	Apr-Sep	Moyle, 2002; CDFG, 2010
Central Valley steelhead	Aug-Mar (Sep-Oct)	N/A	1-3 years	Jan-Jun	Moyle, 2002; CDFG, 2010
Delta smelt	Dec-Mar (Jan)	Feb-July (Apr-May)	4-5 months	N/A	Moyle, 2002; Bennett, 2005
Longfin smelt	Winter	Nov-June (Feb-Apr)	0-2 months	Jan-Aug (Apr-June)	Moyle, 2002
Sacramento splittail	Dec-Mar	Feb-July (Mar-May)	All Year	N/A	Moyle, et al., 1995; Moyle, 2002
Striped bass	Apr-June	Apr-May	All Year	N/A	SWRI, 2003

Note:
N/A = not applicable because these species do not spawn in the Delta

Stressors Affecting Delta Fish Species

Pelagic organisms (organisms that live at or near the water's surface) live in the ocean or in estuaries like the Delta. Many pelagic organisms provide a resource base in the Delta food web, and can be considered key indicator species of the overall health and condition of the system they inhabit.

Since approximately 2005, there has been a significant effort to study the declining native fish populations in the Delta. The Interagency Ecological Program (IEP), consisting of scientists and managers representing six federal and three state agencies, is evaluating the possible causes of pelagic organism decline

(Baxter et al., 2010). In June 2006, the Legislature directed the Resources Agency to report on proposed actions to address the pelagic organism decline, and to stabilize the ecosystem in the Delta.

Since approximately 2002, the abundance indices calculated by the IEP fall Midwater Trawl survey demonstrated significant declines in numerous pelagic fishes within the Delta including the delta smelt, longfin smelt, age-0 striped bass, and threadfin shad (Baxter et al., 2010). The declines of these four species appeared to occur simultaneously despite the differences in their life histories and how these species utilize Delta habitats, suggesting that one of more Delta-wide factors contributed to the decline (Baxter et al., 2010).

The basic conceptual model for the pelagic organism decline contains four major components based on the following hypotheses: (1) prior fish abundance - continued low abundance of adults leads to low juvenile production (i.e., stock-recruitment effects); (2) habitat - the amount of water (volume or surface area) with suitable conditions for a species has changed because changes in estuarine water quality variables, disease, and toxic algal blooms in the estuary affect survival and reproduction; (3) top-down effects - predation and water project entrainment affect mortality rates; and (4) bottom-up effects - consumable resources and food web interactions affect survival and reproduction (Baxter et al., 2010). Stressors affecting the fish species of primary management concern within the Delta are discussed below.

Delta Agricultural Diversions

There are approximately 2,200 water diversions within the Delta (Herren and Kawasaki, 2001; Reclamation, 2008). Although entrainment by agricultural diversions is not frequently identified as a factor in the decline of Delta fish species, most of these small diversions are not screened (Herren and Kawasaki, 2001). The majority of the diversions divert water to agricultural fields between April and August. The early part of this irrigation season coincides with the timing of spawning and larval development of fish species of primary management concern in the Delta. Because spawning and larval development are likely to occur in shallow shoreline locations and movement is limited, entrainment of these life stages by agricultural diversions may be more substantial (Reclamation, 2008).

Reverse Flows

The CVP and SWP both divert water from Old River, a tidal slough that intersects the lower San Joaquin River. CVP and SWP diversions can cause the tidally averaged flow in the Old River, Middle River, and other adjacent channels in the southern Delta to reverse flow toward the diversions. These reverse flows contribute to the entrainment of numerous fish species, including migrating and spawning delta smelt. Patterns of entrainment vary with life history and season, as well as food availability and water quality (Grimaldo et al., 2009).

Reverse flows also affect downstream migrating juvenile Chinook salmon and steelhead. Pilot studies of the effect of Delta Cross Channel (DCC) operations on the movement of juvenile Chinook salmon in the Delta indicate that yearlings will move into the Delta Cross Channel during flood tides, and can be drawn into the channel after initially migrating past the channel gates (CALFED, 2000).

Non-Native Species

The Delta is one of the most biologically invaded estuaries in the world. Non-native species have been introduced intentionally and unintentionally. Many introduced species are considered undesirable, and some of these species are believed to adversely affect the ecosystem within the Delta. For example, since the introduction of the overbite clam (*Corbula amurensis*), there has been a reduction of the phytoplankton,

thereby affecting the productivity of the estuary with a corresponding reduction in zooplankton and pelagic fish production. Historic relationships between Delta outflow and the populations of longfin smelt and striped bass have shifted since the introduction of this clam (Baxter et al., 2010).

The Delta also has experienced successive invasions of copepod species. Copepods are zooplankton that form the food base for many pelagic fishes. The most recently introduced copepod, *Limnoithona tetraspina*, displaced the previously dominant copepod species (*Psuedodiaptomus forbesi*) in the early 1990s. The abundance of other copepods has decreased continuously since its introduction. *Limnoithona* is a less suitable food item than the previous species (Baxter et al., 2010).

Toxins

Anthropogenic and environmental toxins could also have adversely affected fish populations (DWR and CDFG, 2007). Although initial data on striped bass and delta smelt indicated high frequencies of liver lesions and other signs of disease indicative of toxic poisoning (Armor et al., 2005), subsequent studies have shown that acute contaminant toxicity is not likely the cause for population declines, but could be a contributor (Baxter et al., 2010). Two toxins have received special attention: pyrethroid pesticides and *Microcystis* hepatotoxins (toxins that damage the liver).

Pyrethroid pesticides have received special attention in pelagic organism decline studies because of their increased use in recent years and their high toxicity to aquatic organisms. Although pyrethroids are readily absorbed into sediment, they can be mobilized during high flow events and are highly toxic to zooplankton and fish (Werner et al., 2006). Although it has been shown that these pesticides have the capacity to affect pelagic fish populations, a direct link to pelagic organism decline has yet to be demonstrated (Armor et al., 2005).

Microcystis is a colonial cyanobacteria that produces hepatotoxins that can affect both fish and humans. Blooms of *Microcystis* have become larger and more widespread during the summer. Reduced stream flow in the Delta seems to promote the growth of *Microcystis* and is more abundant in dry years (Baxter et al., 2010). *Microcystis* blooms have not yet been identified as a primary cause of the pelagic organism decline (Baxter et al., 2010).

Water Exports

CVP and SWP exports can influence the magnitude of flows into the Delta and the outflow from the Delta into Suisun Bay. Along with Delta inflow, Delta outflow is an important regulator of habitat quality and availability, and fish distribution, survival, and abundance (Baxter et al., 2010). Delta inflow and outflow are important for species residing primarily in the Delta (e.g., delta smelt and longfin smelt) (USFWS, 2008), and juveniles of anadromous species (e.g., Chinook salmon, steelhead, and green sturgeon) that rear in the Delta prior to ocean entry. CVP and SWP operations can increase fish entrainment, redirect fish into areas with higher risks of mortality, affect salinity, and degrade essential habitat conditions. The rate and location that water is diverted from the Delta affects the residence time of water in Delta channels, which affects primary and secondary production. High residence time allow phytoplankton to accumulate in the Delta (Kimmerer, 2004).

Water exports indirectly affect pelagic fish by changing the hydrology and salinity of the estuary. Hydrologic changes caused by water exports include changes in flow magnitude and direction (especially in the south Delta), movement of water from the Sacramento River into and through the central Delta, and changes in the amount of low salinity habitat available for fish that depend on this type of habitat.

Assessment of the indirect effects of exports has been focused largely on the position of the two parts per thousand (ppt) salinity isopleth (i.e., the "X2" location) and the relative abundance of low salinity habitat (USFWS, 2008; NMFS, 2009).

Most of the fish species of special concern are affected by Delta Cross Channel operation, including all races of Chinook salmon, steelhead, American shad, striped bass, and green and white sturgeon. The Delta Cross Channel is not screened. However, the gates of the Delta Cross Channel can be operated to reduce flow from the Sacramento River into the central Delta.

Efforts have been made to reduce water diversions in the spring, when diversions are believed to have the greatest impacts on fish in the Delta. However, during these years, the total amount of water exported from the Delta annually has increased substantially. The most notable changes have included a slight increase in flow down the Sacramento River since 2001, a reduction in peak San Joaquin River outflows since 1999, and increased exports during June through December (DWR and CDFG, 2007).

Delta smelt are affected by Delta Cross Channel operation, both during upstream migrations by spawning adults and during downstream transport of larvae (Reclamation et. al., 2003). Increased winter exports entrain early spawning delta smelt. The early spawners tend to be the largest and most robust individuals. Increased entrainment of the most robust members of the delta smelt population may be weakening the population when combined with other factors, such as increased predation (Bennett, 2005; DWR and CDFG, 2007).

In general, the majority of juvenile Chinook salmon (primarily fall-run Chinook salmon) are primarily observed in salvage operations during the late winter and early spring. The juveniles may include yearling spring-run and fall-run salmon, late fall-run salmon smolts, and pre-smolt winter-run juvenile salmon. Steelhead are primarily observed in salvage during the spring months.

Striped bass are primarily observed in salvage operation during late spring and summer. Delta smelt are primarily observed in salvage operation during the winter and spring months. Longfin smelt are primarily observed in the salvage operation during the spring (Grimaldo et al., 2009). A variety of other resident and migratory fish species are also collected as part of both SWP and CVP salvage operations (Reclamation et. al., 2003). Fish that are not bypassed by the salvage facility may survive passage through the pumps and enter the aqueduct. Fish, including striped bass and resident species, may rear in the canals and downstream reservoirs. These fish support recreational fisheries both in the aqueduct and in downstream reservoirs (Reclamation et al., 2003).

Operation of the SWP, in combination with CVP export operations, influences the hydrology within south Delta channels. Several management actions, including seasonal reductions in SWP and CVP export rates relative to Delta inflow (export/inflow ratio), have been implemented to reduce or avoid adverse effects of changes in hydrology and the vulnerability of species to salvage operations (Reclamation et al., 2003).

Reduced Habitat Quality

Habitat quality is directly related to fish abundance; an overall reduction in habitat quality tends to coincide with long-term declines in delta smelt, striped bass, and threadfin shad (Feyrer et al., 2007). The factors relating to fish abundance are water clarity and specific conductance[2] for delta smelt and striped bass, and specific conductance and temperature for threadfin shad. In addition, several other water quality, physical,

[2] Specific conductance is a measure of how well water can conduct an electrical current; it is an indicator of salinity levels.

and biological parameters, including dissolved oxygen, geomorphology, vegetation, predation, and food availability, could also result in changes in the abundance of these species (Baxter et al., 2010).

The purpose of the South Delta Temporary Barriers Project is to benefit local agricultural diversions by increasing water levels and circulation, and to improve fishery conditions for up-migrating adult salmon and out-migrating smolts (Reclamation et al., 2003). This program was initiated to assess the effects of temporary barriers on water quality, fisheries, and vegetation as a basis for predicting the effects of installing permanent barriers in the southern Delta.

The additional flow in the San Joaquin River helps maintain adequate dissolved oxygen concentrations for adult salmon migrating upstream (Reclamation et al., 2003). The barrier is notched at the top in the fall to allow passage of salmon migrating up Old River to enter the San Joaquin River. During spring, the barrier remains fully closed to prevent downstream migrating salmon smolts in the San Joaquin River from entering Old River, which avoids subsequent exposure to SWP, CVP, and agricultural diversions. In recent years, however, culverts have been installed in the barrier to improve water levels in the south Delta that allow some fish movement from the San Joaquin River into Old River. The other three temporary barriers are traversed by several buried 48-inch pipes, with flap gates on one end that allow unidirectional flow. These barriers operate by allowing water to flow through the pipes and flap gates during flood tides to fill the upstream channels. During ebb tides, the flap gates close to retain water in the channels.

Low Salinity Habitat and X2 Location

The Delta's low salinity habitat (LSH) is an area of the estuary characterized by higher levels of particulates, higher abundances of several types of organisms, and maximum turbidity. As a consequence of higher levels of particulates, the LSH may be biologically significant to some species. It is commonly associated with the location of the 2 ppt salinity isopleth (X2), but actually occurs over a broader range of salinities from 1 to 6 ppt. Historically, mixing and circulation in this area concentrated plankton and other organic material, thus increasing food biomass availability. Since approximately 1987, however, the introduced Asian clam population has reduced much of the primary production in the estuary, and there has been virtually no enhancement of phytoplankton production or biomass in the LSH (Reclamation et al., 2003).

Over the course of a year, X2 location can vary between San Pablo Bay during high Delta outflow (high river flow periods) and Rio Vista during low Delta outflow (summer). In recent years, it has typically been located between approximately Honker Bay and Sherman Island. X2 location is controlled directly by the volume of Delta outflow, although changes in X2 location lag behind changes in outflow. Although recent evidence indicates that X2 location and LSH are not as closely related as previously believed (Reclamation et al., 2003), X2 location continues to be used as an index of the location of LSH.

Predation

Fish (juvenile salmon, juvenile striped bass, and other species) that enter Clifton Court Forebay may reside in the forebay. Once in the forebay, fish may be eaten by other fish or taken by anglers (pre-screening losses); entrained by the pumps at the Banks Pumping Plant (direct loss); impinged on the fish screens at the Skinner Fish Protection Facility (direct loss); or bypassed and salvaged at the Skinner Fish Protection Facility (salvage). CDFG views predation on fish entrained in the forebay as a concern because it may exceed natural predation rates in Delta channels (Reclamation et al., 2003).

The existing intake structure and gates are believed to provide cover and a feeding station for predators. Predation losses are believed to be very high (Reclamation et al., 2003).

Survival of young striped bass in Clifton Court Forebay is also low. Six percent of young-of-the-year striped bass released at the radial gates survived passage across the forebay (Reclamation et al., 2003). The losses for both striped bass and salmon are attributed to predation. Sub-adult striped bass are the major predatory fish in Clifton Court Forebay (Reclamation et al., 2003). These fish are most abundant near the radial gates during winter and spring, when small fish may be particularly vulnerable. Predators have been periodically removed from the Forebay and released in the Delta. In 1993, striped bass made up 96 percent of the predators removed, followed by white catfish and channel catfish (Reclamation et al., 2003).

12.2.2.7 San Francisco Bay Estuary (including San Pablo Bay and Suisun Bay)

The San Francisco Bay Estuary is located at the terminus of the San Joaquin and Sacramento River network, where water draining from the Sacramento Valley enters the Pacific Ocean. It is the largest estuary on the west coast, encompassing roughly 1,600 square miles of central California (NOAA, 2012).

The estuary is surrounded by a contiguous urbanized region and has been greatly modified by 150 years of intensifying human activity (Nichols et al., 1986). Ninety percent of California's remaining coastal wetlands are located in the region. San Francisco Bay is recognized for protection by the California Bays and Estuaries Policy.

The San Francisco Bay Estuary is commonly divided into four different sub-regions: Suisun Bay, North Bay/San Pablo Bay, Central Bay, and South Bay. Each region has a distinct ecological structure defined by the local tidal datum, amount of fresh water influx, sediment input, and the underlying geology (NOAA, 2012). Water passes through the Delta, via the Sacramento-San Joaquin Rivers, and enters Suisun Bay which flows through the Carquinez Straight into San Pablo Bay. San Pablo Bay connects at its south end to Central and South Bays that together form what is known as the "San Francisco Bay".

Suisun Bay is a shallow embayment between Chipps Island at the western boundary of the Delta and the Benicia-Martinez Bridge at the eastern end of Carquinez Strait. Adjacent to Suisun Bay is Suisun Marsh, the largest brackish marsh in the United States. The narrow, 12-mile-long Suisun Bay is a large area of open water that is transitional between the freshwaters of the Delta and the saltwaters of San Francisco Bay; it is a shallow region of wind-stirred, brackish water, lined with tidal marshes (Moyle, 2008). Suisun Marsh is an approximately 74,130-acre marsh that is largely managed as freshwater wetlands to support waterfowl hunting (Moyle, 2008). Suisun Marsh maintains its freshwater character because of inflow from the Sacramento River via Montezuma Slough (Moyle, 2008). Large tidal gates on the upper end of Montezuma Slough control salinity in the marsh by allowing freshwater to flow in but preventing the tides from pushing it back out again (Moyle, 2008).

The estuary's aquatic and wetland habitats range from the brackish water of the lower delta and Suisun Bay to the dilute salt water of San Pablo Bay, and the highly saline waters of South San Francisco Bay (NOAA, 2012). Delta outflow interacts with tides to determine how far salt water intrudes from the ocean into the estuary. Delta outflow varies with hydrology, reservoir releases, and diversions upstream (DWR, 2009).

Fish species that are found in the estuary are virtually the same as those in Delta, although the estuary is more likely to contain euryhaline[3] marine species and early life history stages of estuarine-dependant species such as striped bass, delta smelt, and longfin smelt (Moyle, 2002). Fish species abundance and distribution in the estuary are influenced by seasonal and annual variability in hydrologic conditions,

[3] Capable of tolerating a wide range of salt water concentrations.

including the magnitude of flows into the Delta from the Sacramento and San Joaquin Rivers and other tributaries, outflow from the Delta into San Francisco Bay, and the salinity gradient which varies by region and fluctuates with outflow and tidal actions from the Pacific Ocean (Moyle, 2008).

Table 12-9 lists the species of management concern that are found in estuary. A county-level CNDDB (CDFG, 2009) search was conducted to determine the special-status fish species that may occur within the 22 counties of the Secondary Study Area. For fish species listed pursuant to FESA that could occur within the Delta region and San Francisco Bay Estuary, the Sacramento Fish and Wildlife Office's Endangered Species Program website (USFWS, 2010) was consulted. For species listed pursuant to CESA in this region, the January 2011 Endangered and Threatened Animal List maintained by DFG was consulted (CDFG, 2011a). Documents or data specific to areas and species within the Secondary Study Area were also reviewed to characterize aquatic biological resources.

Table 12-9
Fish Species of Primary Management Concern in the San Francisco Bay Estuary

Species	Scientific Name	Listing Status[a]		Designated Habitat[b]
		Federal	State	
Chinook salmon (Sacramento winter-run)	Oncorhynchus tshawytscha	*FE*	SE	EFH
Chinook salmon (Sacramento spring-run)	Oncorhynchus tshawytscha	*FT*	ST	EFH
Chinook salmon (Sacramento fall/late fall-run)	Oncorhynchus tshawytscha	*C*	CSC	EFH
Central Valley steelhead	Onorhynchus mykiss	*FT*	—	CH
Green sturgeon-southern DPS	Acipenser medirostris	*FT*	CSC	CH
Longfin smelt	Spirinchus thaleichthys	*FSC*	ST	—
Delta smelt	*Hypomesus transpacificus*	*FT*	ST	
Pacific smelt	Thalechthys pacificus	*FT*	CSC	—
River lamprey	Lampetra ayresii	—	CSC	—
Hardhead	Mylopharodon conocephalus	—	CSC	—
Striped bass	*Morone saxatilis*			
Sacramento perch	Archoplites inrerruptus		CSC	—
Tidewater goby	Eucyclogobius newberri	*FE*	CSC	—
Rough sculpin	Cottus asperrimus	—	ST; FP	—
Northern anchovy	Engraulis mordax	—	—	EFH
Pacific sardine	Sardinops sagax caerulea	—	—	EFH
Starry flounder	Platichthys stellatus	—	—	EFH

[a] Listing Status:

FE = Federal endangered
FT = Federal threatened
FSC = Federal species of concern
SE = State endangered
ST = State threatened
FP = State fully-protected species
CSC = state species of special concern

[b] Designated habitat:

CH = Critical habitat
EFH = Essential fish habitat

Note:

DPS = distinct population segment

Source: DFG, 2009, DFG, 2011a, Moyle, 2002, NMFS, 2011.

The San Francisco Bay Estuary supports a spectrum of diverse habitats that are important to the species that inhabit them. Tidal perennial aquatic habitat is one natural community that occurs within greater

San Francisco Bay ecological zones that many fish species of management concern are highly dependent on. Tidal perennial habitat includes deep water aquatic (greater than 10 feet deep from mean lower low tide [the lowest of the low tides in a day]), shallow aquatic (less than or equal to 10 feet deep from mean lower low tide), and unvegetated intertidal (i.e., tideflats) zones of estuarine bays, river channels, and sloughs (Moyle, 2008).

Many fish spend their entire lives in the tidal perennial aquatic community and use it for foraging, spawning, rearing, resting, and migration. Resident and migratory fish use tidal perennial aquatic habitat for spawning, rearing, foraging, and escape cover. Striped bass, delta smelt, Sacramento splittail, and many resident Bay-Delta fish use this habitat for rearing and as adults (CALFED, 2000). Young steelhead and Chinook salmon forage in these productive waters as fry and juveniles to put on weight before entering the ocean. Changes in physical attributes of the water column, such as flow, salinity and water temperature, provide environmental cues for some species to trigger the timing of biological events, such as migration and spawning.

Fish species that currently depend on these tidal marshes and adjoining sloughs, mudflats, and embayments include delta smelt, longfin smelt, Chinook salmon, green sturgeon, white sturgeon, pacific herring, starry. However, many new species of plants and animals have been introduced. These exotic and invasive species, such as the Chinese mitten crab and Asian clam, threaten to undermine the estuary's food web and alter its ecosystem (DWR, 2009).

12.2.3 Primary Study Area

12.2.3.1 Methodology

A CNDDB (CDFG, 2009) search was conducted for Colusa and Glenn counties to determine the special-status fish species that may occur in the Primary Study Area. For fish species listed pursuant to FESA that could occur within the Primary Study Area, the Sacramento Fish and Wildlife Office's Endangered Species Program website (USFWS, 2010) was consulted. For species listed pursuant to CESA in this region, the January 2011 Endangered and Threatened Animal List maintained by DFG was consulted (CDFG, 2011a). Documents or data specific to areas and species within the Primary Study Area were also reviewed to characterize aquatic biological resources. References are cited in the text. In Additionally, DFG conducted fisheries surveys and monitoring within the Primary Study Area (CDFG, 2003; CDFG, 2011c).

12.2.3.2 Waterways that Could be Affected by Project Facilities

The Primary Study Area includes the Sacramento River, Grapevine Creek, Antelope Creek, Funks Creek, Stone Corral Creek, Hunters Creek, Colusa Basin Drain, T-C Canal, GCID Canal, and Funks Reservoir. Fish species of primary management concern found in the Primary Study Area are shown in Table 12-10.

Table 12-10
Fish Species of Primary Management Concern in the Primary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
Central Valley Chinook salmon, winter-run[b]	Sacramento River	FE/CE
Central Valley Chinook salmon, spring-run[b]	Sacramento River	FT/CT
Central Valley Chinook salmon, fall/late fall-run	Sacramento River	FSC/CSSC
Central Valley steelhead[b]	Sacramento River	FT
Green sturgeon	Sacramento River	FT/CSSC
White sturgeon	Sacramento River	None

Table 12-10
Fish Species of Primary Management Concern in the Primary Study Area

Common Name	Range within Watershed	Federal/State Status[a]
River lamprey	Sacramento River and streams throughout Primary Study Area	FSC/CSSC
Pacific lamprey	Sacramento River and streams throughout Primary Study Area	None
California roach	Sacramento River and streams throughout Primary Study Area	CSSC
Sacramento splittail	Sacramento River and Colusa Basin Drain	FT/CSSC
Largemouth bass[c]	Sacramento River, Funks Reservoir, streams throughout Primary Study Area	None
Rainbow trout	Sacramento River	None
Hardhead	Sacramento River	None
American shad	Sacramento River	None
Striped bass	Sacramento River	None

[a]Status designations:
FE = federally-listed as endangered
FT = federally-listed as Threatened
FSC = federally-listed as Species of Concern
CE = California-listed as Endangered
CT = California-listed as Threatened
CSSC = California-listed as Species of Special Concern

[b]Critical Habitat has been designated for this species within the study area.

[c]Includes largemouth bass, smallmouth bass, spotted bass.

Source: DFG, 2009, DFG, 2011a, Moyle, 2002, NMFS, 2011.

Proposed Project facilities within the Primary Study Area, and the waterways that those facilities could affect, are shown in Table 12-11 and in Figure 12-6. The proposed Project Buffer would have the potential to affect the same waterways as the facilities that it would surround.

Table 12-11
Proposed Project Facilities in the Primary Study Area and the Potentially Affected Waterways

Project Facilities	Potentially Affected Waterway
Sites Reservoir Inundation Area	Grapevine Creek, Funks Creek, Stone Corral Creek, Antelope Creek
Sites Reservoir Dams	Stone Corral Creek, Funks Creek
Recreation Areas	None
Roads Relocations and South Bridge	Antelope Creek, Grapevine Creek, Stone Corral Creek, Funks Creek
Delevan Pipeline	Hunters Creek, Colusa Basin Drain
Delevan Transmission Line	None
Delevan Pipeline Intake Facilities and Delevan Pipeline Discharge Facility	Sacramento River
TRR (including the TRR to Funks Creek Pipeline)	Funks Creek
TRR Pipeline, TRR Pipeline Road, TRR Pumping/Generating Plant, TRR Electrical Switchyard, GCID Canal Connection to the TRR, and Delevan Pipeline Electrical Switchyard	None
GCID Canal Facilities Modifications	Sacramento River
Holthouse Reservoir Complex (including Funks Reservoir Dredging)	Funks Creek
Holthouse Reservoir Electrical Switchyard	None
Sites Reservoir Inlet/Outlet Structure	Funks Creek
Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Sites Electrical Switchyard, and Field Office Maintenance Yard	None

Funks Creek, Stone Corral Creek, Grapevine Creek, and Antelope Creek

The portions of Funks, Stone Corral, Grapevine, and Antelope creeks within the Sites Reservoir footprint are characterized by deeply incised channels that are largely devoid of riparian cover as a result of heavy cattle use. On the valley floor, Funks Creek and Stone Corral Creek flow through irrigated pasture, rice fields, and row crop agriculture until they flow into the Colusa Basin Drain. They are incised and riveted in some areas, and have been straightened and probably excavated to facilitate farming. During summer, much of the streambed of all of the Primary Study Area creeks is dry, except for occasional pools or when receiving agricultural drainage or runoff.

Table 12-12 identifies fish species found in Funks Creek, Stone Corral Creek, Grapevine Creek, and Antelope Creek in the proposed Sites Reservoir Inundation Area. These species were observed during sampling conducted between January 1998 and July 1999 (CDFG, 2003). Most of the fish sampled were less than six inches long, suggesting that juveniles rear in these creeks and move downstream to larger bodies of water as adults. Many of the native minnow species found in these creeks typically ascend seasonal creeks in winter and spawn there in early spring (Moyle, 2002). Most adults migrate downstream after spawning. One spring-run Chinook salmon carcass was observed in Antelope Creek during sampling (CDFG, 2003). Live Chinook salmon and Chinook salmon carcasses were also observed in Funks Creek downstream of Funks Reservoir. These fish likely strayed from the Sacramento River during high flows or migrated up the Yolo Bypass and through the Ridge Cut. Suitable Chinook salmon spawning habitat does not exist downstream of Funks Reservoir, and spawning habitat is not known to exist on Antelope Creek as water quality and hydraulic conditions are not suitable to support a population.

Table 12-12
Fish species observed by CDFG during sampling efforts in the Colusa Basin Drain

Common Name	Scientific Name
Central Valley Chinook salmon,	*Oncorhynchus tshawytscha*
White Catfish	*Ictalurus catus*
Brown Bullhead	*Ameiurus nebulosus*
Black Bullhead	*Ameiurus melas*
Channel Catfish	*Ictalurus punctatus*
Bluegill	*Lepomis macrochirus*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Black Crappie	*Pomoxis nigromaculatus*
White Crappie	*Pomoxis annularis*
Pacific Lamprey	*Lampetra ayresi*
Threadfin Sad	*Dorosoma petenense*
California roach	*Hesperoleucus symmetricus*
Hitch	*Lavinia exilicauda*
Fathead Minnow	*Pimephales promelas*
Common Carp	*Cyprinus carpio*
Goldfish	*Carassius auratus*
Sacramento Pikeminnow	*Ptychocheilus grandis*
Sacramento Blackfish	*Orthodon microlepidotus*
Sacramento Splittail	*Pogonichthys macrolepidotus*
Hardhead	*Mylopharodon conocephalus*
Sacramento Sucker	*Catostomus occidentalis*
Inland Silverside	*Menidia beryllina*

Table 12-12
Fish species observed by CDFG during sampling efforts in the Colusa Basin Drain

Common Name	Scientific Name
Mosquitofish	*Gambusia affinis*
Sculpin sp.	*Cottus sp.*
Tule Perch	*Hysterocarpus traski*
Big scale logperch	*Percina macrolepida*

Hunters Creek and the Colusa Basin Drain

The Delevan Pipeline would cross Hunters Creek near its confluence with the Colusa Basin Drain. This stream has not been sampled to determine which fish species are found there. Due to the similar hydrology, channel form, and riparian habitat, Hunters Creek likely has a species composition similar to the streams found in the Sites Reservoir footprint.

The Delevan Pipeline would also cross the Colusa Basin Drain. Historically, the Colusa Basin Drain was a natural channel that transported water from westside tributaries, such as Willow, Funks, Stone Corral, and Freshwater creeks, to the Sacramento River. It also carried floodwater from the Sacramento River. When agricultural operations began in the Sacramento Valley, the Colusa Basin Drain was channelized and dredged to carry agricultural runoff in addition to natural flows. Table 6 identifies the fish species observed during sampling efforts in the drain conducted between January and July 1999 (CDFG, 2003). Fall-, late-fall-, and spring-run Chinook salmon have also been observed in the Colusa Basin Drain. Steelhead may also be present, with potential spawning habitat existing upstream of the Primary Study Area in Willow Creek and Freshwater Creek, but none were captured during sampling efforts (CDFG, 2003).

T-C Canal and GCID Canal

The T-C Canal and the GCID Canal provide habitat for native and non-native fish species. Native fish that are common in the canals are Sacramento sucker, Sacramento pike minnow, hardhead, and hitch. Non-native fish species include striped bass, black bass, sunfish, and common carp. Many of the native fish that occur in the canals likely enter through the intakes as larvae (Reclamation, 2001). Existing screens at the pumping plants are designed to keep Chinook salmon and steelhead from entrainment in the pumps and canals.

Sacramento River at the Delevan Pipeline Intake Facilities, Red Bluff Pumping Plant, and GCID Pumping Plant

The reach of the Sacramento River at the proposed Delevan Pipeline Intake/Discharge Facilities, the existing Red Bluff Pumping Plant, and the existing GCID Pumping Plant provides habitat for migrating adult and juvenile Central Valley steelhead, and winter-, spring-, late-fall-, and fall-run Chinook salmon. Fall- and late-fall-run also spawn in the river near the Red Bluff Pumping Plant and have spawned as far down as the GCID Pumping Plant.

Adult, larval, and juvenile white and green sturgeon also migrate and hold in the vicinity of the proposed pumping plant and the existing Red Bluff and GCID pumping plants. White sturgeon likely spawn in the vicinity of the GCID Pumping Plant and proposed Delevan Pipeline Intake Facilities. Green sturgeon are known to spawn in the vicinity of the Red Bluff and GCID pumping plants (Poytress et al., 2011). It is not known if green sturgeon spawn farther downstream at the proposed Delevan Pipeline Intake/Discharge Facilities site, but tracking data indicates that green sturgeon do not hold in this area during the spawning

period. Sturgeon egg and larva surveys have been conducted on the Sacramento River downstream of Jelly's Ferry Bridge (RM 266.5) to upstream of the GCID Pumping Plant (RM 206.5). Spawning has been confirmed (eggs have been collected) as far upstream as RM 264.5 (near Inks Creek) and as far downstream as RM 206.5 upstream of GCID Pumping Plant) (Poytress et al., 2009, 2011). DFG conducted juvenile salmonid monitoring at the location of the proposed Delevan Pipeline Intake Facilities and approximately one mile upstream of the Tisdale Weir (DFG, 2011c). Sampling showed that juvenile Chinook salmon do migrate past the site in the summer (August), but are most abundant during the winter months (December to February). Chinook salmon juveniles were most abundant during periods of high flow. Abundance decreased as flows receded. The abundance of fish passing the site also appeared to increase during periods of high turbidity (associated with relatively small increases in flow).

12.3 Environmental Impacts/Environmental Consequences

12.3.1 Regulatory Setting

Aquatic biological resources are regulated at the federal, State, and local levels. Provided below is a list of the applicable aquatic resource laws and regulations. These regulations are discussed in detail in Chapter 4 Environmental Compliance and Permit Summary of this DEIR/EIS.

12.3.1.1 Federal Plans, Policies, and Regulations

- Federal Endangered Species Act
- U.S. Fish and Wildlife Service Operations Criteria and Plan Biological Opinion
- National Marine Fisheries Service Operations Criteria and Plan Biological Opinion
- Clean Water Act
- Rivers and Harbors Act of 1899
- Central Valley Project Improvement Act
- National Environmental Policy Act
- Magnuson-Stevens Fishery Conservation and Management Act
- USFWS Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes
- National Marine Fisheries Service Recovery Planning for Salmon and Steelhead in California
- Fish and Wildlife Coordination Act
- Anadromous Fish Restoration Program
- CALFED Bay Delta Program
- National Invasive Species Act of 1996
- Trinity River Restoration Program
- Central Valley Project Long-term Water Service Contracts

12.3.1.2 State Plans, Policies, and Regulations

- California Endangered Species Act
- California Environmental Quality Act
- Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary
- California Fish and Game Code Section 1602 - Streambed Alteration
- The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act
- Natural Community Conservation Planning Act
- California Fish and Game Code Sections 5937 and 5980-5993
- California Aquatic Invasive Species Management Plan

12.3.1.3 Regional and Local Plans, Policies, and Regulations

- Interagency Ecological Program Pelagic Organism Decline Studies
- Delta Vision Strategic Plan
- State Water Resources Control Board and California Environmental Protection Agency Draft Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem

12.3.2 Evaluation Criteria and Significance Thresholds

Significance criteria represent the thresholds that were used to identify whether an impact would be significant. Appendix G of the *CEQA Guidelines* suggests the following evaluation criteria for biological resources:

Would the Project:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?

The evaluation criteria used for impact analysis represent a combination of the Appendix G criteria and professional judgment that considers current regulations, standards, and/or consultation with agencies, knowledge of the area, and the context and intensity of the environmental effects, as required pursuant to NEPA. For the aquatic biological resources impact assessment, indicators (e.g., water temperatures, flows) were used to evaluate whether the Project would have an impact on a species' habitat. The impact indicators and evaluation guidelines were developed based on an extensive review of fisheries literature, with special emphasis on research conducted in the Central Valley. Impact determinations were based on consideration of all evaluated impact indicators for all life stages for a particular species in a particular river or geographic region (e.g., the Delta, the Export Service Area). For the purposes of this analysis, an alternative would result in a significant impact if it would result in the following:

- A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

A detailed description of each of the species and location-specific impact indicators is provided in Appendix 12B.

12.3.3 Impact Assessment Assumptions and Methodology

12.3.3.1 Assumptions

The following assumptions were made regarding Project-related construction, operation, and maintenance impacts to aquatic biological resources:

- Direct Project-related construction and maintenance activities would occur in the Primary Study Area
- The only direct project-related construction activity that would occur in the Secondary Study Area is the installation of an additional pump in an existing bay at the Red Bluff Pumping Plant

- The only direct project-related maintenance activity that would occur in the Secondary Study Area is the sediment removal and disposal at the two intake locations (i.e., GCID Canal Intake and Red Bluff Pumping Plant)
- No direct project-related construction or maintenance activities would occur in the Extended Study Area.
- Direct project-related operational effects would occur in both the Primary Study Area and the Secondary Study Area
- Direct project-related operational effects that would occur in the Extended Study Area are related to San Luis Reservoir operation, increased reliability of water supply to agricultural, municipal, and industrial water users, and the provision of an alternate Level 4 wildlife refuge water supply. Indirect effects to the operation of certain facilities that are located in the Extended Study Area, and indirect effects to the consequent water deliveries made by those facilities, would occur as a result of implementing the alternatives.
- The existing bank protection located upstream of the proposed Delevan Pipeline Intake/Discharge facilities would continue to be maintained and remain functional.
- No additional channel stabilization, grade control measures, or dredging in the Sacramento River at or upstream of the Delevan Pipeline Intake or Discharge Facilities would be required.

12.3.3.2 Methodology

Detailed discussion of the impact assessment methodology, impact indicators, and significance criteria used to evaluate potential impacts of the alternatives on aquatic biological resources, relative to Existing Conditions and the No Project/No Action Alternative for regulatory compliance purposes, is provided in Appendix 12B.

For each of the study areas (i.e., Extended, Secondary, and Primary), the impact assessment identifies fish species of primary management concern. Species of primary management concern include special-status fish species (federal- and State- listed threatened and endangered, federal candidate species and species of concern, and State species of special concern), as well as other recreationally important species (e.g., striped bass and American shad).

Potential impacts on fish species of primary management concern were assessed by evaluating hydrologic and water temperature model outputs to identify changes in aquatic habitat that could potentially impact fish species of primary management concern. The impact assessments relied on model output data, including:

- Simulated riverine, reservoir, and Delta hydrology, and X2 location:
  - Appendix 6B – CALSIM II Modeling (includes overview of modeling framework)
  - Appendix 6C – River Flow Modeling (USRDOM)
  - Appendix 7D – Delta Modeling (DSM2)
- Simulated water temperatures:
  - Appendix 7E – River Temperature Modeling
  - Appendix 7F – Sites Reservoir Discharge Temperature Modeling
- Summarized simulated hydrology and water temperature data (Appendix 12E and Appendix 12F)

- Simulated fisheries habitat and population parameters:
  - Appendix 12G – Sacramento Splittail Usable Flooded Area Analyses
  - Appendix 12I – Delta Pumping Salvage and Entrainment Analysis
  - Appendix 12J – Early Life-Stage Salmon Mortality Modeling
  - Appendix 12K – Salmonid Population Modeling (SALMOD)
  - Appendix 12L – Winter Run Chinook Salmon Life Cycle Modeling (IOS)
  - Appendix 12M – Delta Passage Modeling (DPM)
  - Appendix 12N – Weighted Useable Area Analysis

Not every model output node location or output variable was evaluated. Specific model outputs and output locations evaluated varied by species based on individual species life history periodicities, habitat requirements, and geographic distributions.

A detailed description of the general and species-specific analytical methodologies, model output types, and model output locations used to assess potential impacts on fish species of primary management concern are provided in Appendix 12B. Potential impacts on aquatic biological resources in the Secondary Study Area are discussed in detail in Appendix 12C.

Although operation of the Project facilities is conceptually simple (see Chapter 3 Description of the Proposed Project/Proposed Action and Alternatives), implementation of the action alternatives would alter reservoir operations throughout the SWP and CVP system in ways not necessarily observed historically or evaluated in previous environmental documents. Specifically, simulated average monthly flows and water temperatures frequently increase and decrease by small and large amounts within the same month and among months over the 82-year simulation period. These hydrologic and water temperature changes are easily observed in the model output data, but are difficult to evaluate with respect to fish species of primary management concern.

Mass balance hydrologic and water temperature modeling was performed to provide a quantitative basis from which to assess potential operations-related impacts of the alternatives on fish species of primary management concern and aquatic habitats within the Extended (e.g., San Luis Reservoir) and Secondary (e.g., Trinity, Clear Creek, Sacramento, Feather and American rivers, and the Delta) study areas, relative to the CEQA and NEPA bases of comparison (i.e., Existing Conditions and the No Project/No Action Alternative). Specifically, the hydrological modeling analyses were utilized to simulate data representing Central Valley Project/State Water Project (SWP/CVP) operational conditions that would occur with implementation of the alternatives, as compared to modeled data representing operational conditions for the CEQA and NEPA bases of comparison. Assessment of fish species of primary management concern in the Primary Study Area (e.g., Sites and Funks reservoirs) consisted primarily of evaluation of construction, operation, and maintenance impacts. Both quantitative and qualitative assessments were conducted to evaluate potential impacts to aquatic biological resources that could occur as a result of implementation of the proposed Project. The methodologies used to simulate comparative operational scenarios, and assumptions associated with the alternatives and bases of comparison are described in Appendix 6A and Appendix 6B.

The impact assessment of aquatic biological resources consisted of three primary elements, including: (1) temporary and localized impacts associated with construction of the proposed Project infrastructure facility components; (2) ongoing impacts associated with operation and maintenance of the proposed Project facilities; and (3) ongoing hydrologic changes associated with operation of each of the

alternatives. The detailed analytical approaches used to assess the potential impacts of each of these primary elements of the alternatives are described in Appendix 12B.

12.3.3.3 Extended Study Area

The Extended Study Area consists of the SWP/CVP water service areas, San Luis Reservoir, and the Level 4 wildlife refuges located throughout the water distribution system.

For fisheries impact evaluation purposes, the focus of the analyses was placed on the National Wildlife Refuges (NWR) and San Luis Reservoir.

Level 4 National Wildlife Refuges

Changes to Level 4 water supply reliability could potentially affect fisheries resources in the wildlife refuges or in the water distribution systems within the refuges. Potential changes in water deliveries to individual refuges are not provided as part of the CALSIM II model output. However, implementation of the action alternatives would result in the provision of an alternate source of Level 4 water supply and would not affect supply reliability. Therefore, Level 4 water supply to these refuges was evaluated qualitatively under the alternatives, relative to the bases of comparison.

San Luis Reservoir

Coldwater and warmwater fisheries in San Luis Reservoir were evaluated using the same methodology that was used for the reservoirs included in the Secondary Study Area, as described below.

12.3.3.4 Secondary Study Area

The Secondary Study Area consists of the SWP and CVP water bodies and the waterways within the Sacramento River, Feather River, Trinity River, and American River watersheds that lie outside of the Primary Study Area described above. For fisheries impact evaluation purposes, the Secondary Study Area includes Trinity Lake, the Trinity River, Clear Creek, Shasta Lake, the Sacramento River downstream of Keswick Dam, Lake Oroville, the Feather River, Folsom Lake, Sutter Bypass, the American River, the Yolo Bypass, and the Sacramento-San Joaquin Delta.

General Assessment Approach

Because the alternatives may result in changes in water temperatures and river flows, as well as Delta habitat parameters (e.g., salinity) in the Secondary Study Area, the impact assessment focused on these and other habitat-based elements. Specifically, the analysis of potential impacts was conducted using an ecologically scaled hierarchy. Changes to aquatic ecosystem-level functions (e.g., flow, water temperature) that are relevant to multiple fish species were evaluated first. The results of these analyses were then used to conduct individual fish species evaluations using species-specific habitat requirements and species-specific evaluation tools to identify potential impacts on fish species of primary management concern.

Analytical Tools

The aquatic biological resources impact assessment relied on hydrologic modeling to provide a quantitative basis from which to assess the potential impacts of the alternatives on fish species of primary management concern and their associated habitats within the SWP/CVP system. Specifically, the

hydrological modeling and post-processing applications were utilized to simulate operations expected to occur in SWP/CVP reservoirs and rivers, and the Delta, as a result of implementation of the alternatives.

Hydrologic simulation results of monthly river flows and end-of-month reservoir storages from CALSIM II provided a quantitative basis to assess the potential impacts of operations on fish species, relative to the CEQA and NEPA bases of comparison, for the period of simulation extending from water year 1922 through 2003 (82-year simulation period). These simulated results were then used as inputs to Reclamation's Water Temperature Models (Appendix 7E), which simulate monthly water temperature of the main river systems (Trinity, Sacramento, Feather, and American rivers) for the same simulation period. The Upper Sacramento River Daily Operations Model (USRDOM) and the Sacramento River Water Quality Model (SRWQM) were used to simulate daily flows and water temperatures in the upper Sacramento River. The Reclamation Water Temperature model results were used as inputs to Reclamation's Early Life Stage Chinook Salmon Mortality Model (Salmon Mortality Model) to estimate annual mortality rates for the embryonic life stage of Chinook salmon. Flows and water temperatures were also utilized as inputs to other analytical tools including IOS, SALMOD, and the SacEFT to estimate potential population-level impacts on various life stages and habitat for some Sacramento River fishes. Electrical conductivity (EC) in the Delta was simulated using the DSM 2.

Specific nodes (i.e.; model output locations representing generalized geographic locations) from hydrologic and water temperature model output for fisheries impact assessment purposes, as well as the types of model outputs for flows and water temperatures (e.g., cumulative probability exceedance distributions) are identified by river and species in Appendix 12B. Additionally, detailed discussion of specific modeling tools, the modeling assumptions used to characterize the NODOS Project Alternatives' operations, and the appropriate use of model output results is presented in Appendix 6A and Appendix 6B.

Model Output Parameters Evaluated

Several quantitative model output parameters were evaluated by simulating CVP and SWP operations for each of the alternatives and the bases of comparison, then comparing those outputs to one another to identify differences between each of the alternative outputs. These differences in model output parameters are indicative of habitat or fish population changes that could occur with implementation of each of the alternatives.

Raw model output data included:

- Monthly flow, end-of-month storage, end-of-month reservoir water surface elevation, X2 location, and Old and Middle River (OMR) reverse flows
- Daily flow in the upper Sacramento River
- Monthly water temperature
- Daily water temperature
- Spawning habitat availability (expressed as weighted useable area)

Raw model outputs listed above were conditioned to aggregate data in meaningful ways for aquatic biological resources evaluation purposes. Additionally, raw model outputs were utilized as inputs to Reclamation's Early Life Stage Chinook Salmon Mortality Model, other fish population models (IOS, SacEFT, and SALMOD), and other additional analytical tools (e.g., spreadsheet tools) that allowed for

examination of specific habitat or fish population variables (e.g., spawning flow-dependent habitat availability, south Delta pumping facility fish salvage).

The following types of data products (i.e., conditioned raw model output data) were utilized for evaluating hydrologic and fisheries data:

- Long-term average flow, water temperature, end-of-month reservoir storage, Delta outflow, X2 location, and OMR reverse flows. These output parameters were evaluated by month over the entire period of record and by water year type.
- Exceedance probability distributions (exceedance curves) for flow, water temperature, storage, Delta outflow, X2 location, OMR reverse flows, and IOS production estimates by month. These exceedance probability distributions were developed from ranked and sorted data, and show the percentage of time (probability) that a given value is exceeded. Exceedance probability distributions were evaluated by month over the entire period of record and by water year type.
- Monthly flow-dependent habitat availability curves expressed as weighted useable area for evaluating Chinook salmon and steelhead spawning habitat availability. Flow-dependent habitat is expressed as weighted useable area (WUA) and was evaluated during the spawning months for the entire period of record.
- Monthly salvage density. This estimate of fish taken at the CVP and SWP pumping facilities is calculated by utilizing existing historical salvage densities and applying them to simulated exports at the facilities. Monthly salvage density was evaluated for the entire period of record and by water year type.
- Reclamation's Early Life Stage Chinook Salmon Mortality Model. Early life stage mortality was evaluated over the entire period of record and by water year type.
- SALMOD. Estimates of juvenile production for each run of Chinook salmon in the Sacramento River were evaluated over the entire period of record and by water year type.
- IOS, Delta Passage Model (DPM) and SacEFT. Outputs from IOS and SacEFT were evaluated over the entire period of record and by water year type.

Detailed discussion of models and data products utilized for the aquatic biological resources analyses is provided in Appendix 12B.

Quantitative Evaluation Criteria

Evaluation of potential impacts on fisheries resources included evaluating the net difference in a habitat variable for each of the alternatives, relative to a baseline condition. The habitat variables were evaluated over the entire model period of record (e.g., 82 years for CALSIM II), by water year type (e.g., wet years, above normal years, below normal years), and during the lowest 25 percent of years as defined by the exceedance probability distributions. However, individual model output parameters and data products were also evaluated quantitatively based on the type of parameter examined and the existence in scientific literature of biologically relevant relationships to the parameter. For example, flow is important to maintain aquatic life, but no identified quantitative relationship between flow during Chinook salmon immigration and spawning success exists for the Sacramento River. However, the body of literature does contain information about biological effects that occur to individuals (e.g., stress response) or groups of individuals (e.g., 50 percent mortality) associated with exposure to specific water temperatures. Thus, some model output parameters were

evaluated using specific index values as impact indicators, while other parameters were evaluated utilizing criteria that were not necessarily empirically derived or reported in scientific literature as being associated with a specific biological effect. Detailed discussion of evaluation criteria is provided in Appendix 12B. Evaluation methods and assumptions for each of the model output parameters are described briefly below.

Flow, Storage, Delta Outflow

- Evaluate the net difference in the number of years when flows, storage, or Delta outflow are greater or less than 10 percent different with implementation of the alternatives, relative to a baseline condition
  - Changes of less than 1 percent are considered "noise" in the model
  - Changes between 1 and 10 percent are considered real, but not substantial
  - Changes greater than 10 percent are considered substantial

Water Temperature

- Evaluate the net difference in the number of years that specific index values are exceeded with implementation of the alternatives, relative to a baseline condition by comparing life stage specific water temperature index values to model output for each alternative
  - Changes less than 0.3°F are considered noise in the model

WUA Curves

- Evaluate differences between the percentage of maximum WUA between the alternatives and a baseline condition
  - Differences in percentage of maximum WUA of 1 percent or greater are considered meaningful

Early Life Stage Mortality, SALMOD, IOS, Delta Passage Model

- Evaluate absolute differences and relative differences (in percentage) with implementation of the alternatives, relative to a baseline condition over the period of record and by water year type
  - A substantial change in any of the model output metrics is considered to be a change of 10 percent or more

X2 Location

- Evaluate changes in X2 location of 1 km or more under an alternative, relative to a baseline condition (for species that don't have specific X2 evaluations)

- Evaluate changes in X2 location between river kilometer (RKm) 65 and RKm 80 of 10 percent or more during September through December

- Fall X2 location is evaluated as an indicator of habitat suitability in this region of the Delta. However, because of the controversy surrounding the Fall X2 delta smelt rearing habitat suitability index described by Feyrer et al. (2010), the habitat suitability index was not used.

- Evaluate the frequency with which average monthly X2 location is maintained at or downstream of 75 km during April through June to evaluate potential effects on American shad eggs and larvae.

Water Surface Elevation

- Evaluate reductions in water surface elevation of six feet or more per month during the March through June warm water fish spawning period.

Old and Middle River (OMR) Reverse Flows

- Evaluate exceedance probability distributions to identify the percentage of time from March through June when OMR flows are less than -1,500 cfs[4] during dry and critical years to evaluate entrainment potential for delta smelt larvae.
- Evaluate the percentage of time from December through February when OMR flows are less than -5,000 cfs to evaluate entrainment potential for delta smelt adults and straying potential for San Joaquin River fall-run Chinook salmon adults.
- Evaluate the percentage of time from December through March when OMR flows are less than -5,000 cfs to evaluate entrainment potential for longfin smelt juveniles and adults.
- Evaluate changes in the frequency with which mean monthly OMR flows are greater than -1,500 cfs during April and May of dry and critical water years to evaluate entrainment potential for longfin smelt larvae.
- Evaluate percentage of time from November through June when OMR flows are less than 2,500 cfs to evaluate entrainment potential into the Central Delta for juvenile Chinook salmon.
- Evaluate percentage of time from October through July when OMR flows are reduced to evaluate entrainment potential into the Central Delta for juvenile steelhead.

Reservoir- and River-Specific Assessment Approach

Changes in SWP/CVP operations resulting from implementation of the alternatives could potentially alter seasonal flows and water temperatures in the Trinity River, Clear Creek, the Sacramento River, the Feather River, the American River, and the Delta.

The river-specific fisheries impact assessment focused on the hydrologic changes, including reservoir water surface elevation, storage, and instream flows and water temperatures associated with implementation of the alternatives. Taking into account species-specific habitat requirements, operational components of the alternatives were assessed to evaluate potential impacts on identified fish species of primary management concern and associated aquatic habitat.

Because the fish species that inhabit, traverse, or utilize these areas could differ among regions, the fisheries impact assessment approach varied among geographic areas. Further, information available from modeling efforts differed among rivers. Therefore, the river-specific impact assessment included identification of fish species of primary management concern, model output and node locations, and species and life stage-specific evaluation methodologies for the alternatives.

Where specific flow requirements have not been developed for species evaluated in a specific river, potential flow-related impact determinations were based on an evaluation of the frequency and magnitude of change in modeled monthly mean flow for the alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative). Impact determinations related to water temperature were based on species and life stage-specific water temperature impact indicator values

[4] Negative Old and Middle river flows imply that the average flow in Old and Middle Rivers is reversed and the flow is towards the south Delta pumps.

(presented in Appendix 12B and with detailed description of literature describing index value selection criteria presented in Appendix 12D).

Trinity, Shasta, Oroville, and Folsom Reservoirs

Implementation of the alternatives could potentially result in alterations to storage volumes and water surface elevations in Trinity, Shasta, Oroville, and Folsom reservoirs, which could potentially affect reservoir fish species. Model output parameters derived from CALSIM II used to determine potential impacts included:

- End-of-month (average annual monthly) reservoir storage volume
- End-of-month (average annual monthly) water surface elevations.

During the period when these reservoirs are thermally stratified (generally April through November), coldwater fish within the reservoir reside primarily within the reservoir's metalimnion[5] and hypolimnion[6] where water temperatures remain suitable. Reduced reservoir storage during this period could reduce the reservoir's coldwater pool volume, thereby reducing the quantity of habitat available to coldwater fish species during these months. Reservoir coldwater pool size generally decreases as reservoir storage decreases, although not always in direct proportion because of the influence of reservoir basin shape. Therefore, to assess potential storage-related impacts on coldwater fish habitat availability in Trinity, Shasta, Oroville, and Folsom reservoirs, end-of-month storage simulated for the alternatives were compared to end-of-month storage simulated for the bases of comparison for each month of the April through November period.

Because reservoir warmwater fish species[7] use the warm upper layer of the reservoir and nearshore littoral habitats, seasonal changes in reservoir storage, as it affects reservoir water surface elevation, and the rates at which water surface elevation change during specific periods of the year, can directly affect warmwater fish nesting and spawning success. To assess the impacts of potential reservoir water surface elevation changes on warmwater fish, the following approach was used. The magnitude of change, as measured in feet with reference to mean sea level (feet msl), in reservoir water surface elevation occurring each month of the primary spawning period for nest-building fish (March through June) simulated for the alternatives was determined and compared to the bases of comparison. Specifically, the number of times that reservoir reductions of six feet or more per month could occur with implementation of the alternatives was compared to the number of occurrences of the same modeled for the bases of comparison.

A detailed description of the specific methods utilized to evaluate coldwater and warmwater fish species in each of the existing reservoirs potentially affected by implementation of the alternatives is provided in Appendix 12B.

Trinity River

Project operations are not expected to substantially alter instream flows, water temperatures, or habitat conditions for fish inhabiting the Trinity River. However, as part of the impact assessment, modeling

[5] thermocline; thin, distinct layer that separates regions differing in temperature

[6] below thermocline; dense, bottom layer of water

[7] Largemouth bass are evaluated as an indicator species in this EIR/EIS analysis to reflect potential impacts on warmwater game fishes.

results were reviewed and an analysis conducted on seasonal flows, water temperatures, and habitat availability in the Trinity River.

Changes in SWP/CVP operations associated with implementation of the alternatives could potentially alter instream flow and seasonal water temperatures in the Trinity River below Lewiston Reservoir and adversely affect Trinity River fish species. CALSIM II was used to evaluate potential impacts associated with changes in flow, and Reclamation's Water Temperature Model was used to assess water temperatures in the Trinity River. Additionally, Reclamation's early life stage mortality model was used to evaluate water temperature-related mortality on fall-run Chinook salmon in the Trinity River.

A detailed description of the specific methods, including life stage periodicity and model output node locations utilized to evaluate species of primary management concern in the Trinity River, is provided in Appendix 12B.

Clear Creek

Water operations in Clear Creek, including diversions to Clear Creek from the Trinity River, are components of the integrated operations of the Trinity River Division CVP system. From Whiskeytown Lake, water is released through the Spring Creek Power Conduit to the Spring Creek Powerplant and into Keswick Reservoir (up to 2,000 cfs). As part of the CVP system, implementation of one of the alternatives has the potential to affect Clear Creek flows and water temperatures, thereby potentially affecting habitat for species of primary management concern.

Changes in SWP/CVP operations associated with the alternatives could potentially alter instream flow and seasonal water temperatures in the Clear Creek below Whiskeytown Dam and adversely affect Clear Creek fish species. Therefore, CALSIM II was used to evaluate potential impacts associated with changes in flow, and Reclamation's Water Temperature Model was used to assess water temperatures.

Detailed description of the specific methods, including life stage periodicity and model output node locations utilized to evaluate species of primary management concern in Clear Creek, is provided in Appendix 12B.

Sacramento River

Shasta Reservoir releases, and therefore, Sacramento River flow, often are governed by water temperature requirements below Keswick Dam for April through October, and an end-of-September minimum carryover storage for Shasta Reservoir of 1.9 million acre feet (MAF) to protect Sacramento River winter-run Chinook salmon. To meet the temperature objectives, a dynamic evaluation of ambient air temperature, weather forecasts, water temperature at the release point, and release rate occurs. Determination of the appropriate release rate is often made based on the temperature of the water released rather than on the rate needed to support CVP operations.

While water temperature and carryover storage targets for winter-run Chinook salmon generally govern Shasta Reservoir releases, the Sacramento River below Keswick Dam is utilized by a number of fish species of management concern, either as habitat during one or more of their life stages, or as a migration corridor to available habitat in Sacramento River tributaries. Changes in SWP/CVP operations resulting from implementation of the alternatives could potentially alter seasonal flows and water temperatures in the Sacramento River, which in turn could affect the relative habitat availability for fish species that are present in the Sacramento River.

The potential for changes in flows and water temperatures resulting from implementation of one of the alternatives to impact fish resources of the Sacramento River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature methodologies for the Sacramento River fisheries assessment are discussed in detail in Appendix 12B. The following tools were utilized for analyses of specific habitat variables:

- CALSIM II – Flow
- Reclamation Water Temperature Model – Water Temperature
- Reclamation Early Life Stage Mortality Model – Chinook salmon early life stage mortality
- Flow-Habitat Relationships – Chinook salmon spawning WUA
- SALMOD – Chinook salmon population mortality and production potential
- IOS/DPM – Winter-run Chinook salmon population survival and female spawner abundance
- SacEFT – Steelhead spawning habitat availability, egg-to-fry survival, nest (redd) dewatering, redd scour, juvenile stranding, and juvenile rearing habitat; green sturgeon water temperature-related egg mortality

A detailed description of the specific methods, including life stage periodicity and model output node locations utilized to evaluate species of primary management concern in the Sacramento River, is provided in Appendix 12B.

Feather River

Because implementation of the alternatives may result in changes to Feather River flows and water temperatures, the impact assessment focuses on these and other habitat-based elements. Taking into account species-specific habitat requirements, operational components of the alternatives were assessed to evaluate potential impacts on identified fish species of primary management concern and associated aquatic habitat.

The potential for changes in flows and water temperatures resulting from implementation of the alternatives to impact fish resources of the Feather River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature methodologies for the Feather River fisheries assessment are discussed in detail in Appendix 12B. The following tools were utilized for analyses of specific habitat variables:

- CALSIM II – Flow
- Reclamation Water Temperature Model – Water Temperature
- Reclamation Early Life Stage Mortality Model – Chinook salmon early life stage mortality
- Flow-Habitat Relationships – Chinook salmon and steelhead spawning WUA

A detailed description of the specific methods, including life stage periodicity and model output node locations utilized to evaluate species of primary management concern in the Feather River, is provided in Appendix 12B.

Sutter Bypass

To determine potential impacts on fish species of primary management concern potentially utilizing the Sutter Bypass, flows available from USRDOM were evaluated at Ord Ferry and Moulton, Colusa, and Tisdale weirs.

Detailed description of the specific methods utilized to evaluate species of primary management concern in the Sutter Bypass is provided in Appendix 12B.

American River

Because implementation of the alternatives may result in changes to American River flows and water temperatures, the impact assessment focused on the hydrologic changes associated with implementation of the alternatives.

Flows and water temperatures in the American River are controlled by operations of Folsom Reservoir. The impact evaluation on fishery resources requires an understanding of fish species' life histories and life stage-specific environmental requirements (see Affected Environment discussion), and the ability to meet them in the American River.

The potential for changes in flows and water temperatures resulting from implementation of one of the alternatives to impact fish resources of the American River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature assessment methodologies for the American River fisheries assessment are discussed in detail in Appendix 12B. The following tools were utilized for analyses of specific habitat variables:

- CALSIM II – Flow
- Reclamation Water Temperature Model – Water Temperature
- Reclamation Early Life Stage Mortality Model – Fall-run Chinook salmon early life stage mortality
- Flow-Habitat Relationships – Fall-run Chinook salmon and steelhead spawning WUA

A detailed description of the specific methods, including life stage periodicity and model output node locations utilized to evaluate species of primary management concern in the American River, is provided in Appendix 12B.

Sacramento-San Joaquin Delta and Yolo Bypass

The alternatives have the potential to influence aquatic habitat conditions by potentially altering Delta inflow and water export operations. Therefore, aquatic habitat conditions and export operations (e.g., fish salvage operations) were evaluated to identify potential impacts on Delta species of primary management concern.

Because the alternatives have the potential to influence aquatic habitat conditions by potentially altering Delta inflow and water export operations, the following were evaluated:

- Water temperature
  - Water temperatures derived from Reclamation's Water Temperature Model in the lower reaches of the Sacramento River were used because Delta water temperatures from the DSM2 model were not available.
- Delta outflow
- X2 location
- Old and Middle River reverse flows
- Fish salvage and entrainment loss

Detailed description of the specific methods, including life stage periodicity and model output node locations utilized to evaluate species of primary management concern in the Sacramento-San Joaquin Delta, is provided in Appendix 12B. A detailed description of the methods and results of the fish salvage and entrainment loss modeling are provided in Appendix 12I.

In addition to the variables described above, the Delta Passage Model (DPM) was utilized to evaluate survival of Chinook salmon through the Yolo Bypass and the Delta. Additional detail regarding the DPM is provided in Appendix 12M.

The Yolo Bypass also was evaluated using CALSIM II flows for those species potentially utilizing the Yolo Bypass for spawning and rearing.

12.3.3.5 Primary Study Area

The Primary Study Area is comprised of the locations where the following proposed facilities would be constructed, modified, and/or operated: (1) the Sites Reservoir and associated facilities including the Holthouse Reservoir Complex, the TRR and associated facilities, and the Delevan Pipeline and associated facilities; (2) the Delevan Pipeline intake and discharge facilities on the Sacramento River; (3) the T-C Canal and Red Bluff Pumping Plant intake facility on the Sacramento River; and (4) the GCID Canal and intake facility on the Sacramento River.

Construction-Related Impacts

Construction-related impacts were evaluated for the new intake structure and pipeline, for infrastructure modifications at the existing points of diversion and conveyance, as well as for potentially affected water bodies in the immediate project vicinity of the proposed Sites Reservoir. The impact mechanisms evaluated for construction-related impacts included:

- Erosion, sedimentation, and turbidity
- Hazardous materials and chemical spills
- Aquatic habitat modification
- Hydrostatic pressure waves, noise, and vibration
- Stranding and entrainment potential
- Entrainment risk
- Fish passage
- Direct physical injury and/or mortality.

Within the Primary Study Area, NODOS Project construction-related impacts could potentially occur through direct contact of construction personnel, equipment, and/or debris, and generally would be limited to the area in the immediate vicinity of the construction footprint, and short distances downstream.

Potential construction-related impacts to resident and anadromous fisheries resources and aquatic habitat would depend on:

1. Location and type of infrastructure component to be constructed
2. Proximity of construction access routes, staging areas, and storage and disposal areas to waterways
3. Timing of construction activities
4. Specific techniques used

5. Potential for construction-related activities to directly harm individuals and/or remove, damage, or alter onsite habitat conditions within and adjacent to the construction footprint

6. Specific minimization and avoidance measures implemented before, during, and after construction

For each proposed project infrastructure component, the assessment was based on several considerations, including the duration and extent of construction-related activities, as well as the proximity of construction-related activities to waterways. Construction-related impacts could include: (1) changes in aquatic habitat quantity and quality; (2) changes in aquatic and riparian vegetation; and (3) changes in the composition of predator and prey fish community interactions within the immediate NODOS facility footprint area.

Detailed discussion of assessment methodology for the Primary Study Area is provided in Appendix 12B.

Operations- and Maintenance-related Impacts

The impact assessment methodology for the Primary Study Area addressed the operations and maintenance of Sites Reservoir facilities, Holthouse Reservoir Complex facilities, and the three points of diversion on the Sacramento River. The impact mechanisms evaluated for operations-related impacts included fish screen impingement and entrainment associated with water diversions, and temperature effects to the Sacramento River, resulting from Sites Reservoir releases. A detailed description of the assessment methodologies utilized to evaluate potential operations and maintenance impacts on aquatic biological resources is provided in Appendix 12B.

12.3.4 Topics Eliminated From Further Analytical Consideration

Several SWP/CVP re-regulating reservoirs that are located within the Secondary Study Area, including Lewiston Lake downstream of Trinity Dam, Whiskeytown Lake downstream of Lewiston Dam, Keswick Reservoir downstream of Shasta Dam, the Thermalito Complex downstream of Oroville Dam, and Lake Natoma downstream of Folsom Dam, have been eliminated from consideration for these analyses. No storage- or elevation-related impacts on fishery resources in these reservoirs are expected to occur with implementation of the alternatives, relative to the bases of comparison. As regulating afterbays, the re-regulating reservoirs are operated to receive highly variable flows and, as a result, monthly storage and elevation fluctuate significantly on a daily and hourly basis. Therefore, changes in releases from upstream reservoirs under the alternatives would not affect monthly mean storage or elevation, relative to the CEQA or NEPA baseline conditions. Consequently, no assessment of potential storage- or elevation-related impacts on biological aquatic resources in re-regulating reservoirs is warranted.

The following facilities within the Primary Study Area were not evaluated in detail because they would not be located within or adjacent to a waterway; therefore construction, operation, or maintenance of these facilities would not be anticipated to affect aquatic biological resources:.

- Recreation Areas
- Sites Electrical Switchyard
- Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure
- Field Office Maintenance Yard
- Terminal Regulating Reservoir (TRR)
- GCID Canal Connection to the TRR
- TRR Pumping/Generating Plant

- TRR Electrical Switchyard
- TRR Pipeline
- TRR Pipeline Road
- Delevan Transmission Line
- Delevan Pipeline Electrical Switchyard

12.3.5 Impacts Associated with the No Project/No Action Alternative Relative to Existing Conditions

The fourteen proposed projects that are included in the No Project/No Action Alternative and their associated potential impacts to aquatic biological resources within the three study areas are summarized below.

12.3.5.1 DWR - Mayberry Farms Subsidence Reversal and Carbon Sequestration Project

The creation of permanently flooded wetlands on Sherman Island associated with the Mayberry Farms Subsidence Reversal and Carbon Sequestration Project could increase local food availability, which could benefit aquatic species.

12.3.5.2 CCWD - Contra Costa Canal Fish Screen Project

Installation of fish screens at the Rock Slough diversion associated with the Contra Costa Canal Fish Screen Project is expected to minimize the entrainment losses of fish species in the Delta, which could benefit fisheries resources. Improvements at the diversion site also would potentially reduce predation on fish species.

12.3.5.3 CCWD, Reclamation, and DWR - Middle River Intake and Pump Station

Construction of the Alternative Intake Project would result in the installation of a new intake in the Delta, which could result in changes to local hydrodynamics and entrain or impinge fish species, as well as increase susceptibility of fish species to predation near the intake.

12.3.5.4 DWR – Federal Energy Regulatory Commission License Renewal for Oroville Project

Relicensing of the Oroville Facilities could result in operational changes in hydrology of Oroville Reservoir, Thermalito Afterbay, and the Feather River, which could affect aquatic biological resources in these locations. Effects of relicensing activities on reservoir storage and surface elevations, as well as Feather River flows and temperatures, are included in the assumptions associated with the hydrologic model simulations of the No Project/No Action Alternative. Therefore, operations-related effects on aquatic biological resources resulting from Oroville Facilities Relicensing efforts are evaluated below in conjunction with other No Project/No Action Alternative operations-related effects.

12.3.5.5 Freeport Regional Water Authority and Reclamation - Freeport Regional Water Project

Construction of both a new water intake facility/pumping plant on the Sacramento River and a 17-mile underground water pipeline within Sacramento County in association with the Freeport Regional Water Project could result in entrainment and impingement of fish species and result in changes in flow-dependent habitat availability downstream of the intake facility. Operation of the facility is included in the hydrologic model assumptions and potential effects on aquatic habitat are evaluated using hydrologic model results.

12.3.5.6 Reclamation District 2093 - Liberty Island Conservation Bank

Conservation and restoration of aquatic habitat at Liberty Island associated with the Liberty Island Conservation Bank is expected to provide additional habitat for native Delta fish species and anadromous fish species, which could provide for increased foraging and rearing habitat availability, and potentially result in increased survival of Delta and anadromous fish species.

12.3.5.7 City of Stockton - Delta Water Supply Project

Diversion of water from the Delta associated with the Delta Water Supply Project could result in changes in local hydrodynamics causing an increase in susceptibility of fish species to predation, and the possibility of entrainment or impingement of fish species.

12.3.5.8 Reclamation and SWRCB - Battle Creek Salmon and Steelhead Restoration Project

Restoration of salmonid habitat along Battle Creek and its tributaries due to changes in instream flows, removal of diversion dams, and construction of fish ladders and fish screens at other diversion dams associated with the Battle Creek Salmon and Steelhead Restoration Project is anticipated to improve and expand salmonid spawning, rearing, and migration habitat. This may result in increased abundance, productivity, and diversity, as well as improved spatial structure, of anadromous salmonid populations in Battle Creek.

12.3.5.9 Tehama Colusa Canal Authority and Reclamation - Red Bluff Diversion Dam Fish Passage Improvement Project

Modification of the Red Bluff Diversion Dam associated with the Red Bluff Diversion Dam Fish Passage Improvement Project is anticipated to reduce or minimize impacts on migration of anadromous fish species. The four-month “gates in” operation (May 15 through September 15) is expected to be discontinued once the new pumping plant is completed in 2012.

12.3.5.10 Reclamation, CDFG, and Natomas Central Mutual Water Company - American Basin Fish Screen and Habitat Improvement Project

This project involves modifications to the Natomas Central Mutual Water Company and other private water diversions on the Sacramento River and Natomas Cross Canal associated with the American Basin Fish Screen and Habitat Improvement Project, including installation of one or two positive-barrier fish screen diversion facilities; decommissioning and removal of the Verona Diversion Dam and lift pumps; removal of five pumping plants and one small private diversion; and modification of the existing distribution system. These activities are anticipated to reduce or minimize entrainment of juvenile fishes at these water diversions.

12.3.5.11 Reclamation – Delta-Mendota Canal/California Aqueduct Intertie

Construction of an intertie between the Delta-Mendota Canal and the California Aqueduct is anticipated to provide greater operational flexibility for the SWP and CVP, which could benefit Delta fish species.

12.3.5.12 Reclamation, USACE, SAFCA, and CVFPB - Folsom Dam Safety and Flood Damage Reduction Project

Dam safety and flood control improvements at Folsom Dam associated with the Folsom Dam Safety and Flood Damage Reduction Project are not anticipated to substantially affect fisheries resources.

12.3.5.13 Yolo County - Yolo County General Plan Update

Additional residential and commercial growth in Yolo County (within the Central Valley and along the Sacramento River within the Delta) is provided for under the Yolo County General Plan. This growth could result in indirect water quality-related effects on aquatic biological resources, due to potential increases in stormwater runoff into the Sacramento River and the Delta from new development. Effects associated with discrete development projects will be evaluated individually during the environmental review process for each of those potential development projects.

12.3.5.14 Zone 7 Water Agency and DWR - South Bay Aqueduct Improvement and Enlargement Project

Improvement and expansion of the South Bay Aqueduct associated with the South Bay Aqueduct Improvement and Enlargement Project is not anticipated to substantially affect aquatic biological resources.

A summary of changes in aquatic habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the export service area resulting from implementation of the No Project/No Action Alternative, relative to Existing Conditions, is presented in Table 12-13. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas resulting from implementation of the No Project/No Action Alternative, relative to Existing Conditions, is presented in Table 12-14. Species-specific summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.5.15 Extended and Secondary Study Areas – No Project/No Action Alternative

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Potential impacts on reservoir coldwater fish species associated with implementation of the No Project/No Action Alternative were evaluated in Trinity, Shasta, Oroville, and Folsom reservoirs in the Secondary Study Area; and in San Luis Reservoir and other export service area reservoirs in the Extended Study Area. Within the Secondary Study Area and San Luis Reservoir in the Extended Study Area,

reservoir storage was evaluated. Within the Extended Study Area, SWP and CVP exports were evaluated as an indicator of potential changes to export service area reservoirs.

Reservoir coldwater fish species habitat conditions for the No Project/No Action Alternative would be similar to Existing Conditions in Shasta and San Luis reservoirs. In Trinity Reservoir, the expected slightly increased end-of-month storages indicate improved coldwater reservoir fish species habitat conditions. However, habitat conditions in Oroville and Folsom reservoirs would be slightly less suitable as a result of slightly decreased reservoir storages. Similarly, export service area reservoir habitat conditions are anticipated to be slightly less suitable because patterns of Delta exports would change and would be reduced more frequently, and would be reduced by 10 percent or more during some months of critical years. Additionally, although exports would increase slightly most of the time during six months of the year, and decrease slightly during the remaining six months of the year, large decreases in exports would also occur, which could potentially result in large reductions in storage during some years.

Reservoir coldwater fish species are not considered state or federal special status species, but are evaluated for their recreational importance. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, potential impacts on reservoir coldwater fish species in Trinity, Shasta, Oroville, Folsom, and San Luis and other export service area reservoirs are considered **less than significant**.

Reservoir Warmwater Fish Species

Potential impacts on reservoir warmwater fish species associated with implementation of the No Project/No Action Alternative were evaluated in Trinity, Shasta, Oroville, and Folsom reservoirs in the Secondary Study Area; and in San Luis Reservoir and other export service area reservoirs in the Extended Study Area. Within the Secondary Study Area and San Luis Reservoir in the Extended Study Area, net changes in water surface elevation reductions of 6-feet or more during the warmwater fish nesting season were evaluated. Within the Extended Study Area, SWP and CVP exports were evaluated as an indicator of potential changes to export service area reservoirs.

Reservoir warmwater fish species habitat conditions for the No Project/No Action Alternative would be similar to Existing Conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs. However, export service area reservoir habitat conditions are anticipated to be slightly less suitable for reasons described for coldwater reservoir fish species, above.

Reservoir warmwater fish species are not considered state or federal special status species, but are evaluated for their recreational importance. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on reservoir warmwater fish species in Trinity, Shasta, Oroville, Folsom, and San Luis and other export service area reservoirs.

Southern Oregon/Northern California Coho Salmon

Potential impacts associated with implementation of the No Project/No Action Alternative on Southern Oregon/Northern California Coho salmon were evaluated only in the Trinity River. Flows and water temperatures were evaluated to identify potential changes in Trinity River habitat conditions that could potentially impact Coho salmon.

In general, habitat conditions in the Trinity River would be similar under the No Project/No Action Alternative, relative to Existing Conditions.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on Coho salmon in the Trinity River.

Upper Klamath-Trinity River Fall-Run and Spring-Run Chinook Salmon

Potential impacts associated with implementation of the No Project/No Action Alternative on Upper Klamath-Trinity River fall-run and spring-run Chinook salmon were evaluated only in the Trinity River. Flows and water temperatures were evaluated to identify potential changes in Trinity River habitat conditions that could potentially impact Upper Klamath-Trinity River fall-run and spring-run Chinook salmon. Additionally, water temperature-related early life stage mortality was evaluated using Reclamation's Early Life Stage Mortality Model.

In general, during the periods when Chinook salmon are present in the Trinity River, habitat conditions, as well as early life stage mortality, would be similar under the No Project/No Action Alternative, relative to Existing Conditions.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on spring-run and fall-run Chinook salmon in the Trinity River.

Klamath Mountains Province Steelhead

Potential impacts associated with implementation of the No Project/No Action Alternative on Klamath Mountains Province steelhead were evaluated only in the Trinity River. Flows and water temperatures were evaluated to identify potential changes in Trinity River habitat conditions that could potentially impact steelhead.

In general, during the periods when steelhead are present in the Trinity River, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on steelhead salmon in the Trinity River.

Sacramento River Winter-Run Chinook Salmon

Potential impacts associated with implementation of the No Project/No Action Alternative on Sacramento River winter-run Chinook salmon were evaluated in the Sacramento River, Sutter Bypass, Delta, and Suisun, San Pablo, and San Francisco bays (bays). Flows, water temperatures, and spawning habitat availability were evaluated to identify potential changes in habitat conditions at various locations. Additionally, water temperature-related early life stage mortality, population mortality, production potential, population survival, and female spawner abundance were evaluated using various modeling tools. Through-Delta survival was evaluated using the Delta Passage Model component of IOS.

In general, during periods when winter-run Chinook salmon are present in the Sutter Bypass, Delta, and bays downstream of the Delta, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. Habitat conditions in the Sacramento River would be similar but slightly less suitable as a result of slightly less suitable spawning and embryo incubation conditions more often. However, slightly less suitable conditions in the Sacramento River would not result in substantial effects because reductions in habitat suitability would be small in magnitude and occur relatively infrequently (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on winter-run Chinook salmon in the Sacramento River, Sutter Bypass, Delta, and the bays.

Central Valley Spring-Run Chinook Salmon

Potential impacts associated with implementation of the No Project/No Action Alternative on Central Valley spring-run Chinook salmon were evaluated in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Delta, and bays. Flows, water temperatures, and spawning habitat availability were evaluated to identify potential changes in habitat conditions at various locations. Additionally, water temperature-related early life stage mortality, and population mortality and production potential, were evaluated using various modeling tools. Through-Delta survival was evaluated using the Delta Passage Model.

In general, during periods when spring-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in Clear Creek would be slightly improved during all life stages due to increased flows and decreased water temperatures occurring more frequently under the No Project/No Action Alternative, relative to Existing Conditions (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on spring-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Delta, and the bays.

Central Valley Fall-Run Chinook Salmon

Potential impacts associated with implementation of the No Project/No Action Alternative on Central Valley fall-run Chinook salmon were evaluated in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Delta, and bays. Flows, water temperatures, spawning habitat availability, and OMR reverse flows were evaluated to identify potential changes in habitat conditions at various locations. Additionally, water temperature-related early life stage mortality, and population mortality and production potential, were evaluated using various modeling tools. Through Delta survival was evaluated using the Delta Passage Model.

In general, during periods when fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in Clear Creek would be slightly improved during all life stages due to increased flows and decreased water temperatures occurring more frequently. Additionally, habitat conditions in the American River would be substantially less suitable during all life stages (see Appendix 12C for a detailed discussion). Specifically, decreased flows and increased water temperatures, as well as increased early life stage mortality would occur more frequently, as a result of implementation of the No Project/No Action Alternative.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on fall-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, Sutter Bypass, Delta, and bays**,** but **there would be a potentially substantial adverse effect** on fall-run Chinook salmon in the American River.

Central Valley Late Fall-Run Chinook Salmon

Potential impacts associated with implementation of the No Project/No Action Alternative on Central Valley late fall-run Chinook salmon were evaluated in the Sacramento River, Clear Creek, Sutter Bypass, Delta, and bays. Flows, water temperatures, and OMR reverse flows were evaluated to identify potential changes in habitat conditions at various locations. Additionally, water temperature-related early life stage mortality, and population mortality and production potential, were evaluated using various modeling tools. Through-Delta survival was evaluated using the Delta Passage Model.

In general, during periods when late fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. Additionally, habitat conditions in Clear Creek would be generally similar or improved during all life stages due to increased flows and decreased water temperatures occurring more frequently (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on late fall-run Chinook salmon in the Sacramento River, Clear Creek, Sutter Bypass, Delta, and bays.

Central Valley Steelhead

Potential impacts associated with implementation of the No Project/No Action Alternative on Central Valley steelhead were evaluated in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays. Flows, water temperatures, Delta outflow, and OMR flows were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated. Additionally, spawning, embryo incubation, and juvenile rearing and emigration conditions in the Sacramento River were evaluated using SacEFT, and spawning habitat availability in the Feather River was evaluated using flow-habitat relationships.

In general, during periods when steelhead are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in Clear Creek would be similar during most years, but would be more suitable for all life stages during low flow conditions as a result of increased flows and decreased water temperatures occurring more frequently. Additionally, habitat conditions in the American River would be substantially less suitable for juvenile rearing and emigration, and smolt emigration, as a result of decreased flows and increased water temperatures occurring more frequently, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on steelhead in the Sacramento River, Clear Creek, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays**,** but **there would be a potentially substantial adverse effect** on steelhead in the American River.

Green Sturgeon

Potential impacts associated with implementation of the No Project/No Action Alternative on green sturgeon were evaluated in the Trinity River, Sacramento River, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays. Flows and water temperatures were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities

also was evaluated. Additionally, water temperature-related egg survival in the Sacramento River was evaluated using SacEFT.

In general, during periods when green sturgeon are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in the American River would be substantially less suitable during all life stages due to decreased flows and increased water temperatures occurring more frequently, particularly during low flow conditions (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on green sturgeon in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays, but **there would be a potentially substantial adverse effect** on green sturgeon in the American River.

White Sturgeon

Potential impacts associated with implementation of the No Project/No Action Alternative on white sturgeon were evaluated in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays. Flows and water temperatures were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when white sturgeon are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions.

White sturgeon are not considered State or federal special status species, but are evaluated for their recreational importance. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on white sturgeon in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays**.**

Pacific Lamprey

Potential impacts associated with implementation of the No Project/No Action Alternative on Pacific lamprey were evaluated in the Trinity River, Sacramento River, Clear Creek, Feather River, American River, Delta, and bays. Flows and water temperatures were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when Pacific lamprey are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in Clear Creek would be similar during most years, but would be more suitable for all life stages during low flow conditions as a result of increased flows occurring more often. Additionally, habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows and increased water temperatures occurring more frequently, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Pacific lamprey are not considered special status species in California, but are evaluated because the USFWS in Oregon and Washington considers Pacific lamprey to be a species of concern. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse**

effect on Pacific lamprey in the Trinity River, Sacramento River, Clear Creek Feather River, Delta, and bays**,** but **there would be a potentially substantial adverse effect** on Pacific lamprey in the American River**.**

River Lamprey

Potential impacts associated with implementation of the No Project/No Action Alternative on river lamprey were evaluated in the Sacramento River, Clear Creek, Feather River, American River, Delta, and bays. Flows and water temperatures were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when river lamprey are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in Clear Creek would be similar during most years, but would be more suitable for all life stages during low flow conditions as a result of increased flows occurring more often. Additionally, habitat conditions in the American River would be substantially less suitable for all life stages, due to decreased flows and increased water temperatures occurring more frequently, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on river lamprey in the Sacramento River, Clear Creek, Feather River, Delta, and bays are considered **less than significant,** but **there would be a potentially substantial adverse effect** on river lamprey in the American River.

Hardhead

Potential impacts associated with implementation of the No Project/No Action Alternative on hardhead were evaluated in the Sacramento River, Clear Creek, Feather River, and American River. Flows and water temperatures were evaluated to identify potential changes in habitat conditions at various locations.

In general, during periods when hardhead are present in the Sacramento and Feather rivers, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. Habitat conditions in Clear Creek would be similar during most years, but would be more suitable for all life stages during low flow conditions due to increased flows occurring more often. Additionally, habitat conditions in the American River would be similar during spawning but less suitable for other life stages due to decreased flows occurring more frequently (see Appendix 12C for a detailed discussion). However, because habitat conditions during spawning would be similar, and reduced habitat suitability for other life stages would be a result of decreased flows occurring more frequently while water temperatures remain within the range considered suitable, reduced flows alone would not be anticipated to result in a substantial effect on the population.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on hardhead in the Sacramento River, Clear Creek, Feather River, and American River.

California Roach

Potential impacts associated with implementation of the No Project/No Action Alternative on roach were evaluated in the Sacramento River, Clear Creek, Feather River, and American River in the Secondary Study Area, and in Level 4 wildlife refuges in the Extended Study Area. Within the Extended Study Area, habitat conditions were evaluated based on anticipated conditions resulting from implementation of the

No Project/No Action Alternative. Within the Secondary Study Area, simulated flows and water temperatures were evaluated to identify potential changes in habitat conditions at various locations.

Within the Secondary Study Area, during periods when roach are present in the Sacramento and Feather rivers, habitat conditions generally would be similar under the No Project/No Action Alternative, relative to Existing Conditions. Habitat conditions in Clear Creek would be similar during most years, but would be more suitable for spawning during low flow conditions as a result of increased flows occurring more often. Additionally, habitat conditions in the American River would be similar during spawning but less suitable for other life stages due to decreased flows occurring more often (see Appendix 12C for a detailed discussion). However, because habitat conditions during spawning would be similar, and reduced habitat suitability for other life stages would be a result of decreased flows occurring more frequently while water temperatures remain within the range considered suitable, reduced flows alone would not be anticipated to result in a substantial effect on the population. Habitat conditions within the Extended Study Area are anticipated to be similar under the No Project/No Action Alternative, relative to Existing Conditions.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on California roach in the Sacramento River, Clear Creek, Feather River, American River, and Level 4 wildlife refuges.

Delta Smelt

Potential impacts associated with implementation of the No Project/No Action Alternative on delta smelt were evaluated in the Yolo Bypass, Delta (some analyses included model nodes in the lower reaches of the Sacramento River), and bays. Flows, water temperatures, X2 location, Delta outflow, salvage and entrainment, and OMR flows were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when delta smelt are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on delta smelt in the Yolo Bypass, Delta, and bays.

Longfin Smelt

Potential impacts associated with implementation of the No Project/No Action Alternative on longfin smelt were evaluated in the Delta (some analyses included model nodes in the lower reaches of the Sacramento River), and bays. Flows, water temperatures, X2 location, Delta outflow, salvage and entrainment, and OMR flows were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when longfin smelt are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions.

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on longfin smelt in the Delta and bays.

Sacramento Splittail

Potential impacts associated with implementation of the No Project/No Action Alternative on splittail were evaluated in the Feather River, American River, Sutter Bypass, Yolo Bypass, and Delta in the

Secondary Study Area; and in Level 4 wildlife refuges in the Extended Study Area. Extended Study Area habitat conditions were evaluated based on anticipated conditions resulting from implementation of the No Project/No Action Alternative. Within the Secondary Study Area, simulated flows, water temperatures, and useable flooded area were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when splittail are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in the American River would be substantially less suitable for spawning, as a result of decreased flows and reduced useable flooded area occurring more often, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on Sacramento splittail in the Feather River, Sutter Bypass, Yolo Bypass, Delta, and Level 4 wildlife refuges, but **there would be a potentially substantial adverse effect** on Sacramento splittail in the American River.

Striped Bass

Potential impacts associated with implementation of the No Project/No Action Alternative on striped bass were evaluated in the Sacramento River, Feather River, American River, Delta, and bays. Flows, water temperatures, and X2 location were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when striped bass are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows occurring more often, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Striped bass are not considered State or federal special status species, but are evaluated for their recreational importance. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on striped bass in the Sacramento River, Feather River, Delta, and bays**,** but **there would be a potentially substantial adverse effect** on striped bass in the American River**.**

American Shad

Potential impacts associated with implementation of the No Project/No Action Alternative on American shad were evaluated in the Sacramento River, Feather River, American River, Delta, and bays. Flows, water temperatures, and X2 location were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when American shad are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows occurring more often, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

American shad are not considered State or federal special status species, but are evaluated for their recreational importance. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on American shad in the Sacramento River, Feather River, Delta, and bays**,** but **there would be a potentially substantial adverse effect** on American shad in the American River.

Largemouth Bass

While largemouth bass are evaluated as a species of recreational importance, they also are evaluated as an indicator of potential impacts on other warmwater game fishes.

Potential impacts associated with implementation of the No Project/No Action Alternative on largemouth bass were evaluated in the Sacramento River, Feather River, American River, Yolo Bypass, and Delta. Flows, water temperatures, X2 location, and monthly Electrical Conductivity (EC) in the Delta were evaluated to identify potential changes in habitat conditions at various locations. Salvage at the SWP and CVP Delta pumping facilities also was evaluated.

In general, during periods when largemouth bass are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to Existing Conditions. However, while flows in the American River would be reduced and water temperatures would be increased, these changes would not be likely to adversely affect largemouth bass or other warmwater game fishes. In fact, the expected reduced flows and more frequently increased water temperatures could potentially benefit largemouth bass by reducing habitat suitability for coldwater fish species, thereby making them more susceptible to predation.

Largemouth bass are not considered State or federal special status species, but are evaluated for their recreational importance. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on largemouth bass in the Sacramento River, Feather River, American River, Yolo Bypass, and Delta.

12.3.5.16 Primary Study Area – No Project/No Action Alternative

Construction, Operation, and Maintenance Impacts

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

No construction, operations, or maintenance activities would occur in the Primary Study Area under the No Project/No Action Alternative. Habitat conditions in Funks and Stone Corral creeks are not anticipated to change with implementation of the No Project/No Action Alternative. However, existing agricultural land use activities in the Primary Study Area are assumed to continue as they do under Existing Conditions. These activities would likely include unrestricted cattle movement within some of the local creeks and continued disturbance to riparian areas. Ongoing land uses and agricultural practices in the Primary Study could result in degraded habitat conditions within Funks and Stone Corral creeks. Therefore, under the No Project/No Action Alternative, relative to Existing Conditions, **there would not be a substantial adverse effect** on fish species and aquatic habitat in Funks and Stone Corral creeks.

12.3.6 Impacts Associated with Alternative A Relative to Existing Conditions

Potential impacts on fish species of primary management concern associated with implementation of Alternative A, relative to Existing Conditions, were evaluated in an identical manner to those described for the No Project/No Action Alternative, relative to Existing Conditions. Specifically, model results and locations evaluated were identical among alternatives.

A summary of changes in habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the Export Service Area under Alternative A, relative to Existing Conditions, is presented in Table 12-15. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas under Alternative A, relative to Existing Conditions, is presented in Table 12-16. Species-specific summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.6.1 Extended and Secondary Study Areas - Alternative A Relative to Existing Conditions

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Reservoir coldwater fish species habitat conditions would be similar or more suitable in Trinity, Shasta, Oroville, and Folsom reservoirs under Alternative A, relative to Existing Conditions. Specifically, within the Secondary Study Area, end-of-month storage generally would be greater more often under Alternative A, relative to Existing Conditions, in Trinity, Shasta and Folsom reservoirs, and would be generally similar in Lake Oroville. Reservoir coldwater fish species habitat conditions would be similar or less suitable in San Luis Reservoir, and similar or generally more suitable in export service area reservoirs due to reduced storage more often in San Luis Reservoir, and potentially increased storage in other export service area reservoirs due to increased SWP/CVP exports.

Therefore, for Alternative A, relative to Existing Conditions, potential impacts on reservoir coldwater fish species in Oroville and San Luis reservoirs are considered **less than significant,** and impacts to coldwater fish species in Trinity, Shasta, Folsom, and other export service area reservoirs are considered **potentially beneficial**.

Reservoir Warmwater Fish Species

Reservoir warmwater fish species habitat conditions would be similar or more suitable under Alternative A, relative to Existing Conditions, in Trinity and Shasta reservoirs because fewer water surface elevation reductions of six feet or more would occur during the warmwater fish nesting season. Therefore, fewer nest dewatering events would be anticipated. Water surface elevation reductions of six feet or more would occur with similar frequency in Oroville Reservoir, and slightly more often in Folsom Reservoir. Therefore, habitat conditions for warmwater fish species are anticipated to be similar in Oroville Reservoir and potentially slightly less suitable in Folsom Reservoir. Habitat conditions in San Luis Reservoir are anticipated to be slightly less suitable because of increased frequencies of water surface elevation reductions of six feet or more, while expected increases in exports more often are anticipated to increase habitat suitability for warmwater fish species inhabiting other export service area reservoirs.

Therefore, for Alternative A, relative to Existing Conditions, potential impacts on reservoir warmwater fish species in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs are considered **less than significant,** and impacts to warmwater fish species in other export service area reservoirs are considered **potentially beneficial**.

Southern Oregon/Northern California Coho Salmon

Construction activities would not impact Southern Oregon/Northern California Coho salmon because they are not found in the Sacramento River.

In general, habitat conditions in the Trinity River would be similar under Alternative A, relative to Existing Conditions because flows would be similar during most life stages, while water temperature index values would be exceeded with similar frequencies during most life stages (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to Existing Conditions, potential operational impacts on Coho salmon in the Trinity River are considered **less than significant**.

Upper Klamath-Trinity River Fall-Run and Spring-Run Chinook Salmon

Construction activities would not impact Upper Klamath-Trinity River fall-run and spring-run Chinook salmon because they are not found in the Sacramento River.

In general, during the periods when Chinook salmon are present in the Trinity River, habitat conditions, as well as early life stage mortality, would be similar or more suitable under Alternative A, relative to Existing Conditions because flows would be similar, but slightly higher during some life stages while water temperature index values would be exceeded with similar or lower frequencies during all life stages (see Appendix 12C for detailed discussion).

Therefore, under Alternative A, relative to Existing Conditions, potential operational impacts on spring-run and fall-run Chinook salmon in the Trinity River are considered **less than significant**.

Klamath Mountains Province Steelhead

Construction activities would not impact Upper Klamath-Trinity River fall-run and spring-run Chinook salmon because they are not found in the Sacramento River.

In general, during the periods when steelhead are present in the Trinity River, habitat conditions would be similar under Alternative A, relative to Existing Conditions, with flows being lower slightly more often and water temperatures being slightly more suitable more often.

Therefore, under Alternative A, relative to the Existing Condition, potential operational impacts on steelhead in the Trinity River are considered **less than significant**.

Sacramento River Winter-Run Chinook Salmon

Construction in the Secondary Study Area would consist of the installation of additional pump into an existing bay at the Red Bluff Pumping Plant during the annual maintenance period for the T-C Canal. Although the canal would be dry during construction, construction activities would occur near the Sacramento River and therefore could potentially impact winter-run Chinook salmon in the Sacramento River as they migrate upstream (adults) or downstream (emigrating juveniles). Potential impact mechanisms include: (1) increases in sedimentation and turbidity; and (2) hazardous materials and chemical spills. These potential impacts could result in reduced habitat suitability, physiological stress and sub-lethal effects, as well as direct mortality to individual fish, which could result in population-level impacts (e.g., reduced spawning activity and subsequent initial year class strength).

Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on winter-run Chinook salmon in the Sacramento River are considered **potentially significant**.

In general, during periods when winter-run Chinook salmon are present in the Sutter Bypass, Delta, and bays downstream of the Delta, habitat conditions would be similar or more suitable under Alternative A, relative to Existing Conditions. Habitat conditions in the Sacramento River would be generally more suitable as a result of more suitable spawning and embryo incubation conditions more often, while habitat conditions in the Delta would be similar or more suitable due to generally higher juvenile survival through the Delta (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on winter-run Chinook salmon in the Sutter Bypass, Delta, and the bays are considered **less than significant,** and operational impacts on winter-run Chinook salmon in the Sacramento River are considered **potentially beneficial**.

Central Valley Spring-Run Chinook Salmon

Construction-related impacts on spring-run Chinook salmon would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on spring-run Chinook salmon in the Sacramento River are considered **potentially significant**.

In general, during periods when spring-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative A, relative to Existing Conditions, due to more frequently increased flows and reduced water temperatures. Habitat conditions in the American River for non-natal juvenile spring-run Chinook salmon would be generally similar or slightly less suitable due to reduced flows occurring more frequently under Alternative A, relative to Existing Conditions. However, it is not anticipated that these habitat conditions would substantially affect spring-run Chinook salmon, particularly because the American River only supports non-natal juvenile rearing (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to Existing Conditions, potential operational- impacts on spring-run Chinook salmon in Clear Creek, Feather River, American River, Sutter Bypass, Delta, and bays are considered **less than significant,** and impacts on spring-run Chinook salmon in the Sacramento River are considered **potentially beneficial**.

Central Valley Fall-Run Chinook Salmon

Construction-related impacts on fall-run Chinook salmon would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on fall-run Chinook salmon in the Sacramento River are considered **potentially significant**.

In general, during periods when fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative A, relative to Existing Conditions. However, habitat conditions in the American River would be substantially less suitable during all life stages (see Appendix 12C for a detailed discussion). Specifically, decreased flows and increased water temperatures, as well as increased early life stage mortality would occur more frequently, as a result of implementation of Alternative A.

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on fall-run Chinook salmon in the Sacramento River, Feather River, Sutter Bypass, Delta, and bays are considered **less than significant.**

On the American River under Alternative A relative to Existing Conditions, impacts on fall-run Chinook salmon would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on fall-run Chinook salmon are considered to be **less than significant**.

Central Valley Late Fall-Run Chinook Salmon

Construction-related impacts on late fall-run Chinook salmon would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on late fall-run Chinook salmon in the Sacramento River are considered **potentially significant**.

In general, during periods when late fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative A, relative to the Existing Condition (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on late fall-run Chinook salmon in the Sacramento River, Clear Creek, Sutter Bypass, Delta, and bays are considered **less than significant**.

Central Valley Steelhead

Construction-related impacts on steelhead would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on steelhead in the Sacramento River are considered **potentially significant**.

In general, during periods when steelhead are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions. However, habitat conditions in Clear Creek would be similar during most years, but would be generally more suitable for all life stages during low flow conditions as a result of increased flows and decreased water temperatures occurring more frequently. Habitat conditions in the American River would be substantially less suitable for adult immigration and holding, juvenile rearing and emigration, and smolt emigration, as a result of decreased flows and increased water temperatures occurring more frequently, particularly during low flow conditions when habitat may be limited. Habitat conditions in the Yolo Bypass would also be less suitable for juvenile rearing and emigration, as a result of decreased frequency of inundation (as identified by reduced Yolo Bypass outflow more often), and potentially reduced Delta productivity as a result of decreased Yolo Bypass inundation frequency (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on steelhead in the Sacramento River, Clear Creek, Feather River, Sutter Bypass, Delta, and bays are considered **less than significant,** and impacts on steelhead in the Yolo Bypass are considered **potentially significant**.

On the American River under Alternative A relative to Existing Conditions, impacts on steelhead would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on steelhead are considered to be **less than significant**.

Green Sturgeon

Construction-related impacts on green sturgeon would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on green sturgeon in the Sacramento River are considered **potentially significant**.

In general, during periods when green sturgeon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative A, relative to Existing Conditions. However, habitat conditions in the American River would be substantially less suitable during all green sturgeon life stages due to decreased flows more often and increased water temperatures occurring with similar or higher frequencies, particularly during low flow conditions. Habitat conditions in the Yolo Bypass would also be less suitable for juvenile rearing and emigration as a result of decreased frequency of inundation (as identified by reduced Yolo Bypass outflow more often), and potentially reduced Delta productivity as a result of decreased Yolo Bypass inundation frequency (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on green sturgeon in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on green sturgeon in the Yolo Bypass are considered **potentially significant**.

On the American River under Alternative A relative to Existing Conditions, impacts on green sturgeon would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on green sturgeon are considered to be **less than significant**.

White Sturgeon

Construction-related impacts on white sturgeon would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on white sturgeon in the Sacramento River are considered **potentially significant**.

In general, during periods when white sturgeon are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions in the Trinity River, Sutter Bypass, Delta and Bays, but would be similar or less suitable in the Sacramento and Feather rivers. Habitat conditions would be less suitable in the Sacramento River due to reduced flows more often during the spawning and embryo incubation lifestage, but water temperatures would not be increased substantially more often. Habitat conditions would be less suitable in the Feather River due to reduced flows more often during all lifestage periodicities, but water temperatures would be generally similar. Additionally, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing due to a decreased frequency of floodplain activation, which results in reduced floodplain rearing opportunities and reduced nutrient inflow to the Delta and bays (see Appendix 12C for a detailed discussion).

Therefore, for Alternative A, relative to Existing Conditions, potential impacts on white sturgeon in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Delta, and bays are considered **less than significant,** and impacts to white sturgeon in the Yolo Bypass are considered **potentially significant**.

Pacific Lamprey

Construction-related impacts on Pacific lamprey would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on Pacific lamprey in the Sacramento River are considered **potentially significant**.

In general, during periods when Pacific lamprey are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions in the Trinity and Sacramento rivers, the Delta and bays, would be similar or more suitable in Clear Creek, would be similar or less suitable in the Feather River, and would be substantially less suitable in the American River. Habitat conditions in Clear Creek would be similar during most years, but would be more suitable for all life stages during low flow conditions as a result of increased flows occurring more often. Habitat conditions in the Feather would be slightly less suitable due to generally reduced flows slightly more often for all life stages. Habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows and similar or increased probabilities of higher water temperatures, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, for Alternative A, relative to Existing Conditions, potential impacts on Pacific lamprey in the Trinity River, Sacramento River, Clear Creek, Feather River, Delta, and bays are considered **less than significant**. On the American River under Alternative A relative to Existing Conditions, impacts on Pacific lamprey would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on Pacific lamprey are considered to be **less than significant**.

River Lamprey

Construction-related impacts on river lamprey would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on river lamprey in the Sacramento River are considered **potentially significant**.

In general, during periods when river lamprey are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions in the Sacramento River, the Delta and bays, would be similar or more suitable in Clear Creek, would be similar or less suitable in the Feather River, and would be substantially less suitable in the American River. Simulated habitat conditions in Clear Creek would be similar during most years, but would be more suitable for all life stages during low flow conditions as a result of increased flows occurring more often. Habitat conditions in the Feather River would be slightly less suitable due to generally reduced flows occurring slightly more often for all life stages. Habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows and similar or increased probabilities of higher water temperatures, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to Existing Conditions, potential operational impacts on river lamprey in the Sacramento River, Clear Creek, Feather River, Delta, and bays are considered **less than significant**. On the American River under Alternative A relative to Existing Conditions, impacts on river lamprey would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on river lamprey are considered to be **less than significant**.

Hardhead

Construction-related impacts on hardhead would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on river lamprey in the Sacramento River are considered **potentially significant**.

In general, during periods when hardhead are present in the Sacramento and American rivers, habitat conditions would be similar under Alternative A, relative to Existing Conditions. Habitat conditions in Clear Creek would be similar during most years, but are more suitable for all life stages during low flow conditions due to increased flows occurring more often. Additionally, habitat conditions in the Feather River would be generally less suitable for all life stages due to decreased flows occurring more frequently (see Appendix 12C for a detailed discussion). However, because reduced habitat suitability would be a result of decreased flows occurring more frequently while water temperatures generally remain within the range considered suitable, reduced flows alone would not be anticipated to result in a substantial impact on hardhead.

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on hardhead in the Sacramento River, Clear Creek, Feather River, and American River are considered **less than significant**.

California Roach

Construction-related impacts on roach in the Sacramento River would be identical to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with

implementation of Alternative A, relative to Existing Conditions, on roach in the Sacramento River are considered **potentially significant**.

Within the Secondary Study Area, during periods when roach are present in the Sacramento, Feather and American rivers, habitat conditions generally would be similar under Alternative A, relative to Existing Conditions. Habitat conditions in Clear Creek would be similar during most years, but would be more suitable for spawning during low flow conditions as a result of increased flows occurring more often. Habitat conditions for roach within the wildlife refuges of the Extended Study Area are anticipated to be similar under Alternative A, relative to Existing Conditions.

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on California roach in the Sacramento River, Clear Creek, Feather River, American River, and Level 4 wildlife refuges are considered **less than significant**.

Delta Smelt

Construction activities would not impact delta smelt because they are not found in the Sacramento River near the construction location.

In general, during periods when delta smelt are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions.

Therefore, under Alternative A, relative to Existing Conditions, impacts on delta smelt in the Delta and bays are considered **less than significant**.

Longfin Smelt

Construction activities would not impact longfin smelt because they are not found in the Sacramento River near the construction location.

In general, during periods when longfin smelt are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions.

Therefore, under Alternative A, relative to Existing Conditions, impacts on longfin smelt in the Delta and bays are considered **less than significant**.

Sacramento Splittail

Construction-related impacts on splittail would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on splittail in the Sacramento River are considered **potentially significant**.

In general, during periods when splittail are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions in the Feather River and the Sutter Bypass. Habitat conditions in the American River would be slightly less suitable for spawning due to decreased flows and reduced useable flooded area occurring slightly more often. The reduction in usable flooded area slightly more often is not anticipated to result in a substantial impact to splittail in the American River. Habitat conditions for splittail within the wildlife refuges of the Extended Study Area are anticipated to be similar under Alternative A, relative to Existing Conditions. Additionally, reduced flows into and out of the Yolo Bypass would result in less suitable habitat conditions for splittail spawning. Because of the importance of the Yolo Bypass to splittail population abundance, reduced

floodplain inundation in the Yolo Bypass constitutes a substantial impact (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to Existing Conditions, potential operational impacts on splittail in the Feather River, American River, Sutter Bypass, Delta, and Level 4 wildlife refuges are considered **less than significant**, and impacts on splittail in the Yolo Bypass are considered **potentially significant**.

Striped Bass

Construction-related impacts on striped bass would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on striped bass in the Sacramento River are considered **potentially significant**.

In general, during periods when striped bass are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions. However, habitat conditions in the Feather River would be similar or less suitable due to lower flows more often during the spawning and early life stage period. Habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows occurring more often, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to Existing Conditions, potential operational impacts on striped bass in the Sacramento River, Feather River, Delta, and bays are considered **less than significant**. On the American River under Alternative A relative to Existing Conditions, impacts on striped bass would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on striped bass are considered to be **less than significant**.

American Shad

Construction-related impacts on American shad would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on American shad in the Sacramento River are considered **potentially significant**.

In general, during periods when striped bass are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions. However, habitat conditions in the Feather River would be similar or less suitable due to lower flows more often during the spawning and early life stage period. Habitat conditions in the American River would be substantially less suitable for all life stages, as a result of decreased flows occurring more often, particularly during low flow conditions when habitat may be limited (see Appendix 12C for a detailed discussion).

Therefore, for Alternative A, relative to Existing Conditions, potential impacts on American shad in the Sacramento River, Feather River, Delta, and bays are considered **less than significant**. On the American River under Alternative A relative to Existing Conditions, impacts on American shad would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative A, the potential operational impacts on American shad are considered to be **less than significant**.

Largemouth Bass

While largemouth bass are evaluated as a species of recreational importance, they also are evaluated as an indicator of potential impacts on other warmwater game fishes.

Construction-related impacts on largemouth bass would be similar to those described for winter-run Chinook salmon. Therefore potential construction-related impacts associated with implementation of Alternative A, relative to Existing Conditions, on largemouth bass in the Sacramento River are considered **potentially significant**.

In general, during periods when largemouth bass are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to Existing Conditions. Habitat conditions in the Delta and Yolo Bypass would be similar or less suitable due to reduced flows into and out of the Yolo Bypass, resulting in reduced habitat availability for all life stages. However, reduced flows in the Yolo Bypass are not likely to adversely impact largemouth bass or other warmwater game fishes. In fact, reduced flows and increased water temperatures occurring more frequently could potentially benefit largemouth bass by reducing habitat suitability for coldwater fish species, thereby making them more susceptible to predation. Additionally, habitat availability in the Delta would be increased during the summer and fall due to reduced EC at various locations.

Therefore, for Alternative A, relative to Existing Conditions, potential impacts on largemouth bass in the Sacramento River, Feather River, American River, and Delta are considered **less than significant,** and impacts to largemouth bass in the Yolo Bypass are considered **potentially significant**.

Ecosystem Enhancement Storage Account – Operational Actions (Project-level Analysis – Alternatives A, B and C)

NODOS Project planners adopted a list of objectives that were incorporated into the operations strategy for the action alternative plans. The objectives, which are referred to as the Ecosystem Enhancement Storage Account (EESA), and their associated potential effects on fish species of primary management concern and aquatic habitat are described below:

- **Improve the reliability of coldwater pool storage in Shasta Lake to increase Reclamation's operational flexibility to provide suitable water temperatures for fish species in the Sacramento River.** This action would operationally translate into an increase in Shasta Lake May storage levels, and increased coldwater pool storage, with particular emphasis on Below Normal, Dry, and Critical water year types. Refer to species-specific SWP and CVP operations analyses for the Sacramento River for potential effects of this action on fish species of primary management concern.
- **Provide releases of appropriate water temperatures from Shasta Dam, and subsequently from Keswick Dam, to maintain mean daily water temperatures year-round at levels suitable for all species and life stages of anadromous salmonids in the Sacramento River between Keswick Dam and Red Bluff Diversion Dam.** Particular emphasis should be placed on the months of highest potential water temperature-related impacts (i.e., July through November) during Below Normal, Dry, and Critical water year types. Refer to species-specific SWP and CVP operations analyses for the Sacramento River for potential effects of this action on fish species of primary management concern.
- **Increase the availability of coldwater pool storage in Folsom Reservoir, by increasing May storage, to allow Reclamation additional operational flexibility to provide suitable water temperatures in the American River.** This action would utilize additional coldwater pool storage by

providing releases from Folsom Dam (and subsequently from Nimbus Dam) to maintain mean daily water temperatures at levels suitable for juvenile steelhead over-summer rearing and fall-run Chinook salmon spawning in the American River from May through November during all water year types. This action may potentially increase the suitability of water temperature conditions in the American River for fish species of primary management concern during May through November of all water year types.

- **Stabilize flows in the American River to minimize dewatering of fall-run Chinook salmon redds (i.e., October through March) and steelhead redds (i.e., January through May), and reduce isolation events (specifically, flow increases to ≥ 4,000-cfs with subsequent reduction to < 4,000 cfs) of juvenile anadromous salmonids, particularly from October through June. Reduce the reliance upon Folsom Reservoir as a "real-time, first response facility" to meet Delta objectives and demands, particularly from January through August, to reduce flow fluctuation and water temperature-related impacts to fall-run Chinook salmon and steelhead in the American River.** This action may potentially reduce fall-run Chinook salmon and steelhead redd dewatering and redd isolation events, and potentially improve water temperature conditions for fall-run Chinook salmon and steelhead in the American River.

- **Provide supplemental Delta outflow during summer and fall months (i.e., May through December) to improve X2 location (if possible, west of Collinsville, 81 km) and increase estuarine habitat, reduce entrainment, and improve food availability for anadromous fishes and other estuarine-dependent species (e.g., delta smelt, longfin smelt).** Refer to species-specific SWP and CVP operations analyses for the Delta for potential effects of this action on fish species of primary management concern. General changes in mean monthly Delta outflow under each modeled Alternative comparison are described below:

  – Alternative A relative to Existing Conditions: Delta outflow would be increased more often during October, December, and June through September, but would be reduced more often during November and January through May.

  – Alternative A relative to the No Project/No Action Alternative: Delta outflow would be increased more often during October, December, and June through September, and would be reduced more often during November and January through April.

  – Alternative B relative to Existing Conditions: Delta outflow would be increased more often during October, December, and June through September, and would be reduced more often during November and January through May.

  – Alternative B relative to the No Project/No Action Alternative: Delta outflow would be increased more often during October, December, and June through September, and would be reduced more often during November and January through May.

  – Alternative C relative to Existing Conditions: Delta outflow would be increased more often during October through December and June through September, and would be reduced more often during January through May.

  – Alternative C relative to the No Project/No Action Alternative: Delta outflow would be increased more often during October, December and June through September, and would be reduced more often during November and January through May

- **Improve the reliability of coldwater pool storage in Lake Oroville to improve water temperature suitability for juvenile steelhead and spring-run Chinook salmon over-summer rearing and fall-run Chinook salmon spawning in the Feather River from May through November during all water year types. Provide releases from Oroville Dam to maintain mean daily water temperatures at levels suitable for juvenile steelhead and spring-run Chinook salmon over-summer rearing, and fall-run Chinook salmon spawning in the Feather River. Stabilize flows in the Feather River to minimize redd dewatering, juvenile anadromous salmonid stranding, and isolation.** Refer to species-specific SWP and CVP operations analyses for the Feather River for potential effects of this action on fish species of primary management concern. In addition, this action may improve the suitability of daily water temperatures for fish species of primary management concern during May through November, and potentially reduce anadromous salmonid redd dewatering and juvenile stranding and isolation in the Feather River.
- **Stabilize flows in the Sacramento River between Keswick Dam and the Red Bluff Diversion Dam to minimize dewatering of fall-run Chinook salmon redds (for the spawning and embryo incubation life stage periods extending from October through March), particularly during fall months.** Refer to species-specific SWP and CVP operations analyses for the Sacramento River for potential effects of this action on fish species of primary management concern.
- **Provide increased flows from spring through fall in the lower Sacramento River by reducing diversions at Red Bluff Diversion Dam (into the Tehama-Colusa Canal) and at Hamilton City (into the Glenn-Colusa Irrigation District Canal), and by providing supplemental flows (at Delevan).** This action would provide multiple benefits to riverine and estuarine habitats, and to anadromous fishes and estuarine-dependent species (e.g., delta smelt, splittail, longfin smelt, and Sacramento splittail) by providing or augmenting transport flows, increasing habitat availability, increasing productivity, and improving nutrient transport and food availability. Refer to species-specific SWP and CVP operations analyses for the Sacramento River and the Delta for potential effects of this action on fish species of primary management concern. To address other aquatic biological resources potentially affected by changes in flows into and through the Delta, changes in modeled Delta outflow were evaluated for each alternative comparison below.

Ecosystem Enhancement Fund – Non-Operational Actions (Programmatic-level Analysis – Alternatives A, B and C)

The Ecosystem Enhancement Fund (EEF) would be established as an endowment to provide long-term funding for aquatic habitat restoration actions on the Sacramento River and its tributaries that do not necessarily require additional water. Projects implemented through the EEF would be in addition to any NODOS Project mitigation, CVPIA, or OCAP requirements.

A Governance Board would manage the fund, prioritize potential projects, and collaboratively determine funded actions, based upon habitat needs. The fund would support planning and implementation of priority non-operational actions. Projects eligible for EEF funding would include those that would directly benefit anadromous fish, with an emphasis on actions in the Sacramento River (e.g. spawning gravel augmentation; sidechannel, riparian, or floodplain restoration; and construction of instream aquatic habitat downstream from Keswick Dam).

These types of restoration projects would potentially result in beneficial effects to fish species of primary management concern, particularly anadromous salmonids and sturgeon. Project-specific environmental

documentation would be completed prior to implementation of actions associated with the Ecosystem Enhancement Fund to identify any potential impacts or benefits to fish species of primary management concern.

12.3.6.2 Primary Study Area - Alternative A Relative to Existing Conditions

Construction, Operation, and Maintenance Impacts

The potential impacts of proposed Project facilities that would be located within or adjacent to waterways are described below.

Sites Reservoir Inundation Area and Sites Dams

Erosion, Sedimentation and Turbidity

Construction activities associated with the Sites Reservoir Inundation Area and Sites Dams, including clearing and grubbing vegetation, would have the potential to cause erosion and contribute sediment to Funks and Stone Corral creeks downstream of the construction activities. During Project operation and maintenance, stream maintenance flows discharged from Sites Reservoir into Funks and Stone Corral creeks, as well as debris and vegetation removal associated with maintenance of the dam embankments, could also result in increased erosion and turbidity. It has been reported that behavioral avoidance of turbid waters may be one of the most important effects on fishes from suspended sediments (Birtwell et al., 1984; DeVore et al., 1980; Scannell, 1988). Exposure duration is reportedly a critical determinant of the occurrence and magnitude of potential physical or behavioral effects on fishes associated with increased turbidity (Newcombe and MacDonald, 1991). While native fish species such as salmonids reportedly appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser, 1991), chronic exposure to increased turbidity can cause physiological stress responses that can increase maintenance energy use and reduce feeding and growth (Lloyd, 1987; Redding et al., 1987; Servizi and Martens, 1991). Because increased turbidity and sedimentation could cause temporary changes in fish behavior, the potential for predation also may be increased. Increased erosion, turbidity, and predation resulting from construction, operation, and maintenance of Sites Reservoir and Dams could result in a **potentially significant impact** to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter Funks and Stone Corral creeks as a result of seepage or accidental spills. During maintenance activities, there is also the potential for chemical or hazardous spills or leakage in these creeks. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas. Hazardous materials and chemical spills associated with the construction and maintenance of Sites Reservoir and Dams could result in a **potentially significant impact** to fish species of primary management concern.

Hydrostatic Pressure Waves, Noise, and Vibration

Construction of Golden Gate and Sites dams on Funks and Stone Corral creeks, respectively, could potentially result in noise-related impacts to fish species in Funks and Stone Corral creeks, resulting in a potentially significant impact to fish species of primary management concern.

However, because Funks and Stone Corral creeks would be temporarily re-routed around the construction areas, potential impacts to fisheries resources would be minimized (see Section 12.4) and are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities also have some limited potential to "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because most equipment to be used during construction, operation, and maintenance activities would be located on land, the potential for direct physical harm would be minimal. Therefore, these activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Water Surface Elevation Fluctuations

Water surface elevation fluctuations may occur within Sites Reservoir once it is constructed and filled, potentially impacting any stocked fisheries that may occur within Sites Reservoir after it becomes operational. However, because no fishery exists in Sites Reservoir under Existing Conditions or the No Project/No Action Alternative, there are **no potential impacts** to aquatic biological resources in Sites Reservoir to evaluate.

Aquatic Habitat Modification

Construction of Sites Reservoir (1.27 MAF under Alternative A) would eliminate and inundate approximately 3.9 miles of Stone Corral Creek and approximately 6.5 miles of Funks Creek upstream of Sites and Golden Gate dams. Stone Corral and Funks creeks are characterized by deeply incised channels with little riparian vegetation or instream cover (Brown, 2000). In addition, water quality is reported to be poor and high in dissolved minerals (Brown, 2000). While the reaches of Funks Creek and Stone Corral Creek that would be inundated generally have little riparian habitat and are ephemeral (Figure 12-7), they have been found to support native and non-native fish species, including California roach, Sacramento blackfish, and Sacramento sucker (Brown, 2000). The reach of Funks Creek immediately downstream of the proposed Sites Dam appears to have more suitable aquatic and riparian habitat compared to other reaches of the creek (Figures 12-8 and 12-9). Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of construction, operation, and maintenance areas year-round. Aquatic habitat removal and modification, specifically the inundation of Funks and Stone Corral creeks associated with the construction of Sites Reservoir, would result in a **potentially significant impact** to fish species of primary management concern.

Operation and maintenance activities in the vicinity of Sites and Golden Gate dams are not anticipated to substantially modify aquatic habitat in Stone Corral or Funks creeks downstream of Sites Reservoir, and would be conducted such that any restored habitat would not be degraded, resulting in a **less than significant impact** to fish species of primary management concern.

Road Relocations and South Bridge

Erosion, Sedimentation and Turbidity

Construction activities associated with road relocations and construction of the South Bridge in the vicinity of Funks and Stone Corral creeks would have the potential to cause erosion and contribute sediment to the creeks downstream of the construction activities, particularly at the proposed Eastside

Road crossing at Funks Creek. It has been reported that behavioral avoidance of turbid waters may be one of the most important effects on fishes from suspended sediments (Birtwell et al., 1984; DeVore et al., 1980; Scannell, 1988). Because increased turbidity and sedimentation could cause temporary changes in fish behavior, the potential for predation also may be increased and could result in a **potentially significant impact** to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter Funks and Stone Corral creeks as a result of seepage or accidental spills. During road and bridge maintenance activities, there is also the potential for chemical or hazardous spills or leakage in these creeks. Accidental discharge of hazardous materials and chemicals could affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas, and could therefore result in a **potentially significant impact** to fish species of primary management concern.

Hydrostatic Pressure Waves, Noise, and Vibration

Construction of the Eastside Road Bridge over Funks Creek may include pile driving activities, potentially resulting in noise-related impacts to fisheries in Funks Creek, which could adversely affect fish species of primary management concern.

However, Funks Creeks would be re-routed away from the construction areas, minimizing any potential impacts to fisheries resources (see Section 12.4) and resulting in a **less than significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities have limited potential to "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because most equipment to be used during construction, operations, and maintenance activities would be located on land, the potential for direct physical harm would be minimal. Therefore, these activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Aquatic Habitat Modification

Construction activities associated with road relocations and bridges in the vicinity of Funks and Stone Corral creeks would have the potential to alter aquatic habitat conditions. Stone Corral and Funks creeks are characterized by deeply incised channels with little riparian vegetation or instream cover (Brown, 2000). The reaches of Funks Creek and Stone Corral Creek that may be affected generally have little riparian and aquatic habitat. It is not anticipated that riparian or aquatic habitat would be permanently removed or substantially impacted by road relocations or bridge construction. Operation and maintenance activities associated with new roads and bridges also are not anticipated to substantially modify aquatic habitat in the downstream reaches of Stone Corral or Funks creeks. Therefore, these activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Fish Passage

It is expected that activities associated with road relocation and bridge construction in the vicinity of Stone Corral and Funks creeks would occur when the creeks are ponded or dry, or when the creeks are

re-routed away from the construction area. Therefore, construction of the Eastside Road Bridge over Funks Creek is not anticipated to substantially affect hydrologic or fish passage conditions within Funks Creek. Construction of any culverts on Funks and Stone Corral creeks would be designed to maintain existing fish passage conditions. Operation and maintenance activities associated with constructed roads and bridges would be conducted in a manner that would not substantially affect fish passage conditions. Therefore, these activities are anticipated to result in a **less than significant** impact to fish species of primary management concern.

Sites Reservoir Inlet/Outlet Structure and Sites Pumping/Generating Plant

Erosion, Sedimentation and Turbidity

Construction activities associated with the Sites Reservoir Inlet/Outlet Structure and the Sites Pumping/Generating Plant along Funks Creek would have the potential to cause erosion and contribute sediment to Funks Creek downstream of the construction activities. It has been reported that behavioral avoidance of turbid waters may be one of the most important effects on fishes from suspended sediments (Birtwell et al., 1984; DeVore et al., 1980; Scannell, 1988). Because increased turbidity and sedimentation could cause temporary changes in fish behavior, the potential for predation also may be increased and could result in a **potentially significant impact** to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter Funks Creek as a result of seepage or accidental spills. During construction activities there would also be the potential for chemical or hazardous spills or leakage into Funks Creek. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas and, therefore, could result in a **potentially significant impact** to fish species of primary management concern.

Hydrostatic Pressure Waves, Noise, and Vibration

Construction of the Sites Reservoir Inlet/Outlet Structure and Sites Pumping/Generating Plant may include construction activities that result in noise and vibration effects to fisheries resources in Funks Creek, potentially impacting fish species in Funks Creek.

However, Funks Creek would be re-routed away from the construction areas to minimize any potential impacts to fisheries resources. Construction activities are therefore anticipated to result in a **less than significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities have limited potential to "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because most equipment to be used during construction, operation, and maintenance activities would be located on land, the potential for direct physical harm would be minimal. Therefore, these activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Aquatic Habitat Modification

Construction of the Sites Reservoir Outlet Structure would permanently remove approximately 0.5 mile of Funks Creek immediately upstream of the existing Funks Reservoir. As previously discussed, Funks Creek is characterized by deeply incised channels with little riparian vegetation or instream cover (Brown, 2000). While the reach of Funks Creek that would be removed generally has little riparian habitat and is ephemeral, it has been found to support native and non-native fish species, including California roach, Sacramento blackfish and Sacramento sucker (Brown, 2000). The reach of Funks Creek immediately downstream of the proposed Holthouse Dam appears to have more suitable aquatic and riparian habitat compared to other reaches of the creek (Figures 12-8 and 12-9). Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of construction, operation, and maintenance areas year-round. Aquatic habitat removal and modification associated with the construction of the Sites Reservoir Inlet/Outlet Structure and Sites Pumping/Generating Plant would result in a **potentially significant impact** to fish species of primary management concern.

Fish Passage

As previously discussed, construction of the inlet/outlet structure would eliminate approximately 0.5 mile of Funks Creek immediately upstream of the existing Funks Reservoir. During construction activities, Funks Creek would be diverted upstream of the inlet/outlet structure construction area, preventing fish passage through the construction area. The extent to which fish species may currently move between Funks Reservoir and Funks Creek upstream of Funks Reservoir is unknown. However, Funks Creek would connect to the approach channel of the inlet/outlet structure to allow flows and fish passage between Funks Creek, the inlet/outlet structure, and Holthouse Reservoir. Operation and maintenance activities associated with the inlet/outlet structure would be conducted as to not substantially affect fish passage conditions. These activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Holthouse Reservoir Complex

The Holthouse Reservoir Complex includes the Holthouse Reservoir and Dam, Holthouse Spillway and Stilling Basin, Holthouse Pumping Plant, T-C Canal Discharge Dissipater, the T-C Canal Bypass Pipeline, and the Holthouse to T-C Canal Pipeline.

Erosion, Sedimentation and Turbidity

Construction of the Holthouse Reservoir Complex would occur adjacent to the existing Funks Reservoir, and thus would have the potential to increase erosion, sedimentation and turbidity in Funks Creek downstream of the construction area. Dredging activities at Funks Reservoir associated with removal of accumulated sediment would also have the potential to increase sedimentation and turbidity in Funks Creek downstream of Funks Reservoir, which could result in a **potentially significant impact** to fish species of primary management concern.

Maintenance activities at the Holthouse Reservoir Complex, such as periodic road, vegetation, and fence maintenance, as well as debris removal, would also have the potential to increase erosion and turbidity in Funks Creek downstream of the proposed Holthouse Reservoir. However, maintenance activities at Holthouse Reservoir are anticipated to be similar to existing maintenance activities at Funks Reservoir, and would be conducted to avoid impacting any aquatic habitat that may have been restored. Flows

released into Funks Creek from Holthouse Reservoir are anticipated to be consistent with flow conditions under Existing Conditions, but have the potential for increasing sedimentation and turbidity in Funks Creek, resulting in a potentially significant impact to fish species of primary management concern. However, construction of a velocity dissipater on the inlet/outlet structure is anticipated to minimize sedimentation and turbidity and result in a **less than significant impact** to fish species of primary management concern (see Section 12.4).

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter Funks Creek as a result of seepage or accidental spills. During operation and maintenance activities, such as debris and sediment removal, dredging, equipment maintenance, and repairs, there would also be the potential for chemical or hazardous spills or leakage in the creek. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas, and could result in a **potentially significant impact** to fish species of primary management concern.

Hydrostatic Pressure Waves, Noise, and Vibration

Construction of the Holthouse Reservoir Complex may involve construction activities that could result in increased noise and vibration levels in local waterways, resulting in a potentially significant impact to fish species of primary management concern.

However, Funks Creek would be re-routed away from the construction area to minimize any potential impacts to fisheries resources and is anticipated to result in a **less than significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities have limited potential to directly "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because Funks Creek would be re-routed away from the construction area, the potential for direct physical harm would be minimal. Therefore, these activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Aquatic Habitat Modification

The construction of the dam and spillway stilling basin, and the consequent inundation of Holthouse Reservoir, would result in the permanent removal of the reach of Funks Creek immediately downstream of the existing Funks Reservoir (approximately 0.7 stream mile) (Figures 12-8 and 12-9). Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of construction, operation, and maintenance areas year-round. Aquatic habitat removal and modification within Funks Creek associated with the construction and inundation of Holthouse Reservoir would result in a **potentially significant impact** to fish species of primary management concern.

Operation and maintenance activities at Funks and Holthouse reservoirs, such as periodic road, vegetation, and fence maintenance, would not be anticipated to substantially affect aquatic habitat in Funks Creek, and would be conducted such that restored areas are not degraded. Operation and

maintenance activities are therefore anticipated to result in a **less than significant impact** to fish species of primary management concern.

Fish Passage

Funks Creek would be diverted during construction activities, and Funks Reservoir would be drained during dredging activities. In-stream construction activities also could impede upstream passage of resident fishes due to altered hydrologic conditions. However, because fish passage is generally blocked at the outlet of the existing Funks Reservoir and the reservoir is drained annually under Existing Conditions, these activities are anticipated to result in a **less than significant impact** to fish species of primary management concern.

Following completion of construction of the Holthouse Reservoir Complex, it is anticipated that fish passage would be blocked downstream of Holthouse Reservoir. However, Flow releases from Holthouse Reservoir into Funks Creek are anticipated to be generally consistent with flow conditions in Funks Creek under Existing Conditions, resulting in a **less than significant impact** to fish species of primary management concern.

GCID Canal Facilities Modifications

Erosion, Sedimentation and Turbidity

Construction activities at the GCID Canal intake and headworks facilities, which involve installing a new headgate structure, lining 200 feet of the canal, and replacing a railroad siphon, have the potential to increase erosion, sedimentation, and turbidity within the GCID Canal and in the Sacramento River in the vicinity of the GCID Canal intake structure. Ongoing maintenance activities, such as sediment removal may also temporarily increase turbidity within the GCID Canal and in the Sacramento River in the vicinity of the GCID Canal intake structure. It has been reported that behavioral avoidance of turbid waters may be one of the most important effects on fishes from suspended sediments (Birtwell et al., 1984; DeVore et al., 1980; Scannell, 1988). Because increased turbidity and sedimentation could cause temporary changes in fish behavior, the potential for predation also may be increased. This could result in a **potentially significant impact** to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter the GCID Canal or the Sacramento River as a result of accidental spills. During operation and maintenance activities, such as debris and sediment removal, and equipment maintenance and repairs, there would also be the potential for chemical or hazardous spills or leakage into the canal and river. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas. This could result in a **potentially significant impact** to fish species of primary management concern.

TRR to Funks Creek Pipeline

Erosion, Sedimentation and Turbidity

Construction of the TRR to Funks Creek Pipeline has the potential to increase erosion, sedimentation, and turbidity within Funks Creek in the vicinity of the proposed pipeline and could therefore result in a **potentially significant impact** to fish species of primary management concern. Discharge operations of

water from the TRR to Funks Creek also have the potential to increase turbidity in Funks Creek. However, a velocity dissipater at the outlet of the pipeline is anticipated to minimize potential increases in turbidity in Funks Creek (see Section 12.4), resulting in a **less-than-significant impact** to fish species of primary management concern.

Ongoing maintenance activities, such as sediment removal, could also temporarily increase turbidity within Funks Creek, resulting in a **potentially significant impact**.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter Funks Creek as a result of accidental spills. During operation and maintenance activities, such as debris and sediment removal, and equipment maintenance and repairs, there would also be the potential for chemical or hazardous spills or leakage into the canal and river. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas, and could result in a **potentially significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities have limited potential to directly "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because most equipment to be used during construction, operation, and maintenance activities would be located on land, the potential for direct physical harm would be minimal. Therefore, these activities are anticipated to result in a **less-than-significant impact** to fish species of primary management concern.

Delevan Pipeline

Erosion, Sedimentation and Turbidity

The Delevan Pipeline would be constructed to convey water from the Sacramento River to Holthouse Reservoir, and also to convey water from Holthouse Reservoir to the Sacramento River. The pipeline would cross the Colusa Basin Drain and Hunters Creek, a tributary to the Colusa Basin Drain. Construction activities at the creek crossings would have the potential to increase erosion, sedimentation, and turbidity within the Colusa Basin Drain and Hunters Creek. However, construction of the Colusa Basin Drain crossing would likely occur during late fall, after the irrigation season ends and before winter rains begin. Portions of the CBD would likely be dewatered so that the pipeline trench could be excavated and the pipeline could be installed. Trench dewatering would involve discharging water into local irrigation ditches and drainage canals after silt is allowed to settle out. Construction would be staged at this crossing and would occur within one half of the channel while an installed coffer dam bypasses flows on the other half of the channel. After installation, the CBD would be returned to service and would be reconstructed to pre-Project conditions. Construction of the Hunters Creek crossing would likely occur when the creek is dry. Construction and dewatering activities would have the potential to increase turbidity levels in adjacent waterways, potentially affecting fisheries resources that may be present and resulting in a **potentially significant impact** to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter the Colusa Basin Drain or Hunters Creek as a result of accidental spills. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction and maintenance areas and could result in a **potentially significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities have limited potential to "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because most equipment to be used during construction, operation, and maintenance activities would be located on land, the potential for direct physical harm would be minimal and is anticipated to result in **a less-than-significant impact** to fish species of management concern.

Aquatic Habitat Modifications

Construction activities required to install the Delevan Pipeline underneath the Colusa Basin Drain and Hunters Creek may require disturbance of aquatic habitat and removal of riparian vegetation, which could result in a **potentially significant impact** to fish species of primary management concern.

Fish Passage

It is not anticipated that the fish species potentially present in the Colusa Basin Drain or Hunters Creek (e.g., centrarchids, Sacramento sucker, Sacramento blackfish, hitch, and California roach) would be substantially affected by a partial and temporary blockage of these waterways. While a few anadromous salmonids are frequently observed in the Colusa Basin Drain during some years, they are not believed to represent a sustainable population and are likely strays from the Sacramento River. Therefore, partial and temporary blockage of the Colusa Basin Drain and Hunters Creek is anticipated to result in a **less-than-significant impact** to fish species of primary management concern.

Delevan Pipeline Intake Facilities

Erosion, Sedimentation and Turbidity

The proposed Delevan Pipeline Intake Facilities on the Sacramento River would include a system of structures to divert water from the Sacramento River, release water to the Sacramento River, and generate electricity when water is released to the Sacramento River. A fish screen structure also would be constructed at the point of diversion. In-river construction would be accommodated by constructing a cofferdam along the entire length of the intake structure (approximately 1,200 feet) and dewatering the area within the cofferdam.

Construction activities associated with construction of the intake facilities, including clearing and grading, transportation of materials, construction of the cofferdam, dewatering the cofferdam, excavation of the forebay and pumping plant site, construction of a berm/ring levee, construction of the facility structures and fish screen system, removal of the cofferdam, fill and re-grading activities, and restoration of disturbed areas after construction all have the potential to increase erosion, sedimentation and turbidity near and downstream of the construction site in the Sacramento River. This increased erosion,

sedimentation, and turbidity could result in a **potentially significant impact** to fish species of primary management concern.

Operation of the intake facilities also has the potential to increase turbidity in the Sacramento River in the vicinity of the intake structure; however, the fish screen would act as a velocity dissipater when water is being released to the Sacramento River, minimizing potential increases in turbidity and resulting in **less-than-significant** impacts.

Maintenance activities, including periodic sediment removal within the forebay and dredging of the intake channel every few years, may result in increased turbidity within the Sacramento River, which would have a **potentially significant impact** on fish species of primary management concern. As discussed for the Secondary Study Area, increases in turbidity in the Sacramento River may temporarily disrupt normal behaviors of fish species that are essential to growth and survival such as feeding, sheltering, and migrating, resulting in a **potentially significant impact** to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction activities could potentially enter the Sacramento River as a result of seepage or accidental spills. During operations and maintenance activities, such as debris and sediment removal, dredging, equipment maintenance, and repairs, there would also be the potential for chemical or hazardous spills or leakage into the Sacramento River. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the construction, operation, and maintenance areas by increasing physiological stress and altering their behavior, which could result in an increased susceptibility to predation. Accidental spills could therefore result in a **potentially significant impact** to fish species of primary management concern.

Direct Harm

In addition to the habitat alteration effects associated with construction, operation, and maintenance activities, these activities have some limited potential to directly "harm" juvenile and adult fishes by direct physical contact, including physical injury or mortality. However, because most equipment to be used during construction, operation, and maintenance activities would be located on land, the potential for direct physical harm would be minimal and is anticipated to result in a **less-than-significant impact** to fish species of primary management concern.

Hydrostatic Pressure Waves, Noise, and Vibration

A cofferdam would be constructed in the Sacramento River along the entire length of the intake structure (approximately 1,200 feet in length) and the isolated area would be subsequently dewatered to allow for construction of the Delevan Pipeline Intake Facilities. Because construction of the cofferdam would include vibratory pile driving in the Sacramento River, fishes in the vicinity could potentially be affected by underwater noise, pressure waves, and vibration. Vibration and pressure waves generated by construction, operation, and maintenance activities could potentially alter fish behavior in the Sacramento River, potentially leading to increased predation risk. Vibration and pressure could, therefore, result in a **potentially significant impact** to fish species of primary management concern.

During landside construction activities associated with the intake facilities, the potential would exist for vibration and pressure waves generated by construction and excavation activities to affect fish species in the Sacramento River. Operation and maintenance activities also may increase ambient underwater noise

levels. However, the noise levels produced by both landside construction and excavation activities, and operation and maintenance activities, are not expected to reach a level that would harm juvenile or adult fishes. Because most construction and excavation activities are anticipated to occur above water, the noise levels under water would be much lower than those created in the air, and are anticipated to result in a **less-than-significant impact** to fish species of primary management concern.

Predation Risk

Construction of the intake facilities on the Sacramento River has the potential to provide habitat for non-native piscivorous predators, such as striped bass and centrarchids, which may result in increased predation risk for other fish species of primary management concern, including outmigrating juvenile salmonids. Increased predation risk associated with the construction of this facility could have a **potentially significant** impact on fish species of primary management concern.

Aquatic Habitat Modification

Activities such as river channel alteration, riparian vegetation and in-stream woody material (IWM) removal, and other in-stream work could potentially reduce biodiversity, macroinvertebrate production, and recolonization of disturbed substrate, as well as limit the exchange of nutrients between surface and subsurface waters and between aquatic and terrestrial ecosystems (USFWS, 2000).

Construction of the Delevan Pipeline Intake Facilities would include the modification and removal of shaded riverine aquatic (SRA) habitat (Figures 12-9 and 12-10). Preliminary estimates using GIS indicate that approximately 1.1 acres of Fremont Cottonwood riparian habitat that acts as SRA habitat, and an additional 0.5 acres of Valley Foothill Riparian habitat that may act as a source of IWM inputs to the Sacramento River, would be removed as a result of construction of the intake facilities. During a reconnaissance site visit conducted on February 23, 2011, available woody material was identified in the area. Examples include one piece of IWM (between six and eight inches in diameter and approximately 20 feet long) that was observed protruding from the river surface, and another piece of similar size that was identified immediately adjacent to the bank that could function as IWM at higher flows (Figure 12-10). The loss and degradation of SRA habitat within the construction footprints and within the access routes, staging areas, and storage and disposal areas could result in an impact to fish species through reduction in the quality of fish habitat and removal of important habitat elements.

Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of construction, operation, and maintenance areas year-round in the Sacramento River. Aquatic habitat removal and modification associated with construction of the intake facility on the Sacramento River would remove aquatic and riparian habitat, including SRA habitat, resulting in a **potentially significant impact** to fish species of primary management concern in the Sacramento River.

Maintenance activities may include replacement of existing riprap necessary to protect the conveyance features and facilities, which is anticipated to result in a **less-than-significant impact** to fish species of primary management concern because no additional habitat would be modified.

Fish Passage

Installation of a cofferdam to facilitate the construction of the intake facilities could potentially physically impede migrating adults, limiting their ability to reach spawning areas, and could hinder migration of juveniles, potentially exposing them to increased predation and unsuitable aquatic habitat conditions. In-stream construction activities also could impede upstream passage of fishes due to altered hydrologic

conditions, such as temporarily increased velocities. However, because the cofferdam would only extend a short distance into the waterway (i.e., 40 feet), relative to the entire width of the Sacramento River, it is not anticipated that the movement or survival of juvenile or adult fish species of primary management concern would be substantially affected. Therefore, installation of a coffer dam is anticipated to result in a **less-than-significant impact** to fish species of primary management concern in the Sacramento River.

Stranding, Impingement and Entrainment

During installation of the cofferdam, any fish that are present potentially could be trapped behind the dam before closure. If individual fish do not exit through the partially enclosed cofferdam and return to the river, stranding of fishes could occur when the enclosed area is dewatered. Because some fish species of primary management concern may be in the vicinity of construction areas year-round, dewatering and in-river work during cofferdam placement and removal could result in fish impingement, entrainment, and stranding, which would result in a **potentially significant impact**.

Operation of the Delevan Pipeline Intake Facilities would also have the potential to entrain or impinge fish species of management concern, resulting in an adverse effect on fish species of primary management concern. However, the intakes would be designed to be protective of anadromous salmonids, and are anticipated to result in a **less-than-significant impact** to fish species of primary management concern.

Temperature Effects on the Sacramento River

Operation of the Delevan Pipeline Intake Facilities would include releases from Sites Reservoir to the Sacramento River. If release temperatures differ from the receiving waters of the Sacramento River, fish species of primary management concern could be adversely affected. However, preliminary modeling results indicate that in more than 98 percent of the months, Sites Reservoir releases would be within 0.5°F of the receiving Sacramento River water temperatures. Even though the model indicates a small number of months (<5%) with a likely cooling impact of 0.2°F or more, the Sites Reservoir temperature results show that it is possible to avoid such impacts by releasing from appropriate outlets. Only one month showed a cooling of more than 1°F in the 82 years. In a few years, mainly in an extended drought period when both Sites Reservoir storage and Sacramento River flow are low, releases from Sites Reservoir would be likely to cause warming of the receiving Sacramento River water. In less than one percent of the months the temperatures in the Sacramento River would increase by 1°F or more due to the releases from the Sites Reservoir. Approximately five percent of the months would likely have a warming impact of 0.2°F or more, although most of the months would be within the same year. The warming impact would mainly occur during September and October months. These slight changes to receiving water temperatures in the Sacramento River would not be expected to adversely affect fish species of primary management concern and are therefore considered to be **less than significant**.

Project Buffer

Erosion, Sedimentation and Turbidity

Ground-disturbing activities associated with the Project Buffer would include the construction of fences and the creation and maintenance of a fuelbreak around the perimeter of the buffer. These activities have the potential to cause erosion and contribute sediment to the creeks adjacent to the locations of these activities. It has been reported that behavioral avoidance of turbid waters may be one of the most important effects on fishes from suspended sediments (Birtwell et al., 1984; DeVore et al., 1980; Scannell, 1988). Because increased turbidity and sedimentation could cause temporary changes in fish

behavior, the potential for predation also may be increased and could result in a **potentially significant impact** to fish species of primary management concern.

12.3.7 Impacts Associated with Alternative A Relative to the No Project/No Action Alternative

Potential impacts on fish species of primary management concern associated with implementation of Alternative A, relative to the No Project/No Action Alternative were evaluated in an identical manner to those described for the No Project/No Action Alternative, relative to Existing Conditions. Specifically, model results and locations evaluated were identical among alternatives.

A summary of changes in habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the export service area under Alternative A, relative to the No Project/No Action Alternative, is presented in Table 12-17. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas under Alternative A, relative to the No Project/No Action Alternative, is presented in Table 12-18. Species-specific summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.7.1 Extended and Secondary Study Areas - Alternative A Relative to the No Project/No Action Alternative

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C. Construction-related impacts associated with implementation of Alternative A relative to the No Project/ No Action Alternative would be the same as those described for Alternative A relative to Existing Conditions. Operational impacts associated with Alternative A relative to the No Project/No Action Alternative are described below.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Reservoir coldwater fish species habitat conditions would be more suitable in Trinity, Shasta, Oroville, and Folsom reservoirs under Alternative A, relative to the No Project/No Action Alternative. Specifically, within the Secondary Study Area, end-of-month storage generally would be greater more frequently under Alternative A, relative to the No Project/No Action Alternative in each of the SWP/CVP reservoirs evaluated. Reservoir coldwater fish species habitat conditions would be similar in San Luis Reservoir, and similar or slightly more suitable in export service area reservoirs due to generally increased SWP and

CVP exports occurring more often and resulting in increased storage in San Luis Reservoir and potentially increased storage in other export service area reservoirs.

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on reservoir coldwater fish species in San Luis and other export service area reservoirs are considered **less-than-significant**, and impacts on coldwater fish species in Trinity, Shasta, Oroville, and Folsom reservoirs are considered **potentially beneficial**.

Reservoir Warmwater Fish Species

Reservoir warmwater fish species habitat conditions would be similar or more suitable under Alternative A, relative to the No Project/No Action Alternative in Trinity and Shasta reservoirs because water surface elevation reductions of six feet or more during the warmwater fish nesting season would occur less frequently. Therefore, fewer nest dewatering events are anticipated. Water surface elevation reductions of six feet or more would be similar in Oroville and Folsom reservoirs. Therefore, impacts on reservoir warmwater fish species are anticipated to be similar. Habitat conditions in San Luis Reservoir are anticipated to be slightly less suitable because of increased frequency of water surface elevation reductions of six feet or more during March, while more frequent increases in exports are anticipated to increase habitat suitability for warmwater fish species inhabiting other export service area reservoirs.

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on reservoir warmwater fish species in Trinity, Shasta, Oroville, Folsom, San Luis, and other export service area reservoirs are considered **less than significant**.

Southern Oregon/Northern California Coho Salmon

In general, habitat conditions in the Trinity River would be similar or more suitable under Alternative A, relative to the No Project/No Action Alternative because flows would be generally similar during most life stages, while water temperature index values would be generally exceeded less frequently during all life stages (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to the No Project/No Action Alternative, potential impacts on Coho salmon in the Trinity River are considered **less than significant**.

Upper Klamath-Trinity River Fall-Run and Spring-Run Chinook Salmon

In general, during the periods when Chinook salmon are present in the Trinity River, habitat conditions, as well as early life stage mortality, would be similar or more suitable under Alternative A, relative to the No Project/No Action Alternative because flows would be generally similar but slightly higher during some life stages, while water temperature index values would be generally exceeded less frequently during all life stages (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to the No Project/No Action Alternative, potential impacts on spring-run and fall-run Chinook salmon in the Trinity River are considered **less than significant**.

Klamath Mountains Province Steelhead

In general, during the periods when steelhead are present in the Trinity River, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative (see Appendix 12C for a detailed discussion).

Therefore, under Alternative A, relative to the No Project/No Action Alternative, potential impacts on spring-run Chinook salmon in the Trinity River are considered **less than significant**.

Sacramento River Winter-Run Chinook Salmon

In general, during periods when winter-run Chinook salmon are present in the Sutter Bypass, Delta, and bays downstream of the Delta, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. Habitat conditions in the Sacramento River would be generally more suitable due to increased flows and decreased water temperatures during low flow conditions, increased spawning habitat availability and reduced water temperatures during spawning, reduced early life stage mortality, reduced population mortality and increased production potential, and increased spawner abundance (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on winter-run Chinook salmon in the Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**, and impacts on winter-run Chinook salmon in the Sacramento River are **potentially beneficial**.

Central Valley Spring-Run Chinook Salmon

In general, during periods when spring-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in the Sacramento River would be more suitable, and would be similar or more suitable in Clear Creek. Specifically, in the Sacramento River flows would be higher more frequently during low flow conditions, and water temperatures would be lower more frequently near Keswick Dam where spawning occurs. Additionally, these conditions would result in reduced early life stage mortality, reduced population mortality, and increased production potential. In Clear Creek, slightly lower water temperatures would occur more frequently (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on spring-run Chinook salmon in Clear Creek, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**, and impacts on spring-run Chinook salmon in the Sacramento River are considered **potentially beneficial**.

Central Valley Fall-Run Chinook Salmon

In general, during periods when fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in Clear Creek would be similar or more suitable due to slightly decreased water temperatures during spawning. Additionally, habitat conditions in the American River would be similar or more suitable due to slightly improved habitat conditions during some life stages (see Appendix 12C for a detailed discussion). Specifically, decreased flows and increased water temperatures, as well as increased early life stage mortality, would result from implementation of the No Project/No Action Alternative.

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on fall-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**.

Central Valley Late Fall-Run Chinook Salmon

In general, during periods when late fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on late fall-run Chinook salmon in the Sacramento River, Clear Creek, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**.

Central Valley Steelhead

In general, during periods when steelhead are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing and emigration, as a result of decreased frequency of inundation (as identified by reduced Yolo Bypass outflow), and potentially reduced Delta productivity as a result of decreased Yolo Bypass inundation frequency (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on steelhead in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on steelhead in the Yolo Bypass are considered **potentially significant**.

Green Sturgeon

In general, during periods when green sturgeon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative A, relative to the No Project/No Action Alternative. Specifically, habitat conditions in the Trinity River, Sacramento River, and American River would be generally more suitable, while conditions in the Feather River would be similar. In the Trinity River, flows would be higher more often during adult immigration, and water temperatures would be lower more often during spawning. In the Sacramento River, particularly in the lower reaches, habitat conditions would be more suitable due to generally higher flows occurring more often during low flow conditions, and generally lower water temperatures occurring more often. In the American River, flows would be higher slightly more often during most life stages, and water temperatures would be slightly lower more often during juvenile rearing and emigration. However, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing due to a decreased frequency of floodplain activation, which would result in reduced floodplain rearing opportunities and reduced nutrient inflow to the Delta and bays (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, potential operational impacts on green sturgeon in the Trinity River, Sacramento River, Feather River, American River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts to green sturgeon in the Yolo Bypass are considered **potentially significant**.

White Sturgeon

In general, during periods when white sturgeon are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, simulated habitat conditions would be similar or less suitable in the Feather River due to

generally similar changes in flows and water temperatures during most life stages, but with lower flows occurring more frequently during the spawning and embryo incubation period. Additionally, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing due to a decreased frequency of floodplain activation, which would result in reduced floodplain rearing opportunities and reduced nutrient inflow to the Delta and bays (see Appendix 12C for a detailed discussion).

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on white sturgeon in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on white sturgeon in the Yolo Bypass are considered **potentially significant**.

Pacific Lamprey

In general, during periods when Pacific lamprey are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in American River would be similar during most years, but would be more suitable for all life stages due to increased flows and decreased water temperatures occurring more frequently. Additionally, habitat conditions in the Feather River would be similar or less suitable during spawning and egg incubation due to inconsistent conditions of increased and decreased flows occurring more frequently in the downstream reaches of the river, as well as increased water temperatures occurring more frequently (see Appendix 12C for a detailed discussion).

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on Pacific lamprey in the Trinity River, Sacramento River, Clear Creek, Feather River, Delta, and bays are considered **less than significant**, and impacts on Pacific lamprey in the American River are considered **potentially beneficial**.

River Lam*p*rey

In general, during periods when river lamprey are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in American River would be similar during most years, but would be more suitable for all life stages due to increased flows and decreased water temperatures occurring more frequently. Additionally, habitat conditions in the Feather River would be similar or less suitable during adult immigration, and for spawning and egg incubation due decreased flows occurring slightly more frequently in the downstream reaches of the river, as well as increased water temperatures occurring slightly more frequently (see Appendix 12C for a detailed discussion). While Feather River conditions would be slightly less suitable for immigration and spawning life stages, these conditions would occur in the lower reaches of the river where spawning occurs infrequently, if it occurs downstream of the Thermalito Afterbay.

Overall, under Alternative A, relative to the No Project/No Action Alternative, potential operational impacts on river lamprey in the Sacramento River, Clear Creek, Feather River, Delta and bays are considered **less than significant**, and impacts on river lamprey in the American River are considered **potentially beneficial**.

Hardhead

In general, during periods when hardhead are present in the Sacramento River and Clear Creek, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative.

Habitat conditions in the Feather River would be similar or more suitable during spawning due to increased flows and suitable water temperatures occurring more often, particularly during low flow conditions. However, habitat conditions in the Feather River would be similar or less suitable due to lower flows occurring more often during portions of the spawning period (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on hardhead in the Sacramento River, Clear Creek, Feather River, and American River are considered **less than significant**.

California Roach

Within the Secondary Study Area and refuges in the Extended Study Area, during periods when roach are present in the water bodies evaluated, habitat conditions generally would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in the American River would be similar or more suitable for spawning due to increased flows and decreased water temperatures occurring more frequently (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, operational impacts on California roach in the Sacramento River, Clear Creek, Feather River, American River, and Level 4 refuges are considered **less than significant**.

Delta Smelt

In general, during periods when delta smelt are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative A, relative to the No Project/No Action Alternative. Specifically, most analyses indicate that habitat conditions would be similar, but downstream movement of X2 location indicates that more suitable habitat conditions would occur during wet, above normal, and below normal water years. Reductions in Yolo Bypass outflow could potentially reduce habitat suitability for delta smelt by reducing nutrient inflow to the Delta. However, improved X2 location during some years could improve juvenile conditions by allowing juveniles to rear in more suitable locations near Suisun and San Pablo bays.

Therefore, under Alternative A, relative to the No Project/No Action Alternative, impacts on delta smelt in the Delta and bays are considered **less than significant**.

Longfin S*m*elt

In general, during periods when longfin smelt are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative.

Therefore, under Alternative A, relative to the No Project/No Action Alternative, impacts on longfin smelt in the Delta and bays are considered **less than significant**.

Sacramento Splittail

Habitat conditions in the American River under Alternative A, relative to the No Action/No Project Alternative would be similar or more suitable during the splittail spawning period due to increased flows occurring more often, particularly during low flow years. In the Feather River, habitat conditions would be similar or slightly less suitable due to decreased flows occurring more often during portions of the spawning period. Additionally, reduced flows into and out of the Yolo Bypass would result in less

suitable habitat conditions for splittail spawning. Because of the importance of the Yolo Bypass to splittail population abundance, reduced floodplain inundation in the Yolo Bypass would constitute a substantial impact (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, potential operational impacts on splittail in the Feather River, American River, Sutter Bypass, Delta, and Level 4 refuges are considered **less than significant**, and impacts on splittail in the Yolo Bypass are considered **potentially significant**.

Striped Bass

In general, during periods when striped bass are present in the evaluated water bodies, habitat conditions would be similar under Alternative A, relative to the No Project/No Action Alternative. However, habitat conditions in the American River would be more suitable due to increased flows and water temperatures within the evaluated range occurring more frequently for all life stages. Additionally, in the Feather River habitat conditions would be similar or less suitable due to reduced flows occurring more frequently during some months of the spawning period (see Appendix 12C for a detailed discussion).

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on striped bass in the Sacramento River, Feather River, Delta, and bays are considered **less than significant**, and impacts on striped bass in the American River are considered **potentially beneficial**.

American Shad

Operations-related impacts on American shad would be similar to those described for striped bass under Alternative A, relative to the No Project/No Action Alternative.

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on American shad in the Sacramento River, Feather River, Delta, and bays are considered **less than significant**, and impacts on American shad in the American River are considered **potentially beneficial**.

Largemouth Bass

In general, during periods when largemouth bass are present in the evaluated water bodies, habitat conditions would be similar under the No Project/No Action Alternative, relative to the Existing Condition. However, habitat conditions in the Yolo Bypass would be less suitable for adults feeding on rearing juvenile fishes in the bypass, as well as juvenile largemouth bass rearing, due to decreased frequency of inundation (as identified by reduced Yolo Bypass outflow), and potentially reduced Delta productivity as a result of decreased Yolo Bypass inundation frequency (see Appendix 12C for a detailed discussion). Additionally, habitat availability in the Delta would be increased during the summer and fall due to reduced EC at various locations.

Therefore, for Alternative A, relative to the No Project/No Action Alternative, potential impacts on largemouth bass in the Sacramento River, Feather River, American River, and Delta are considered **less than significant**, and impacts on largemouth bass in the Yolo Bypass are considered **potentially significant**.

12.3.7.2 Primary Study Area - Alternative A Relative to the No Project/No Action Alternative

Construction, Operation, and Maintenance Impacts

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Refer to the **Impact Fish-1** Primary Study Area discussion for Alternative A relative to Existing Conditions. That discussion also applies to Alternative A relative to the No Project/No Action Alternative.

12.3.8 Impacts Associated with Alternative B Relative to Existing Conditions

Potential impacts on fish species of primary management concern associated with implementation of Alternative B, relative to Existing Conditions, were evaluated in an identical manner to those described for Alternative A, relative to Existing Conditions. Specifically, model results and locations evaluated were identical among alternatives.

A summary of changes in habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the export service area under Alternative B, relative to Existing Conditions, is presented in Table 12-19. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas under Alternative B, relative to Existing Conditions, is presented in Table 12-20. Species-specific summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.8.1 Extended and Secondary Study Areas - Alternative B Relative to Existing Conditions

The impacts associated with Alternative B relative to Existing Conditions, as they relate to fish species of primary management concern (**Impact Fish-1**), would be the same as described for Alternative A relative to Existing Conditions for the following species within the Extended and Secondary study areas:

- Southern Oregon / Northern California Coho
- Upper Klamath / Trinity fall and spring-run Chinook salmon
- Klamath Mountains Province steelhead
- Sacramento River winter-run Chinook salmon
- Central Valley spring-run Chinook salmon
- Central Valley late fall-run Chinook salmon
- Central Valley steelhead
- White sturgeon
- Pacific lamprey
- River lamprey
- Hardhead
- Delta smelt
- Longfin smelt
- Striped bass
- American shad
- Largemouth bass

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C. Construction-related impacts associated with implementation of Alternative B, relative to Existing Conditions, on all fish species of primary management concern would be the same as those described for Alternative A relative to Existing Conditions. Operational impacts associated with Alternative B relative to Existing Conditions that would differ from those described for Alternative A, relative to Existing Conditions, are described below.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Reservoir coldwater fish species habitat conditions would be similar or more suitable in Trinity, Shasta and Oroville reservoirs under Alternative B, relative to Existing Conditions, due to generally higher reservoir storages occurring more often. Reservoir coldwater fish species habitat conditions would be similar in Folsom Reservoir due to generally similar reservoir storages. Simulated habitat conditions would be similar or less suitable in San Luis Reservoir, and similar or generally more suitable in export service area reservoirs due to reduced storage that would occur more often in San Luis Reservoir, and potentially increased storage in other export service area reservoirs due to increased SWP/CVP exports.

Therefore, for Alternative B, relative to Existing Conditions, potential impacts on reservoir coldwater fish species in Oroville, Folsom, and San Luis reservoirs are considered **less than significant,** and impacts to coldwater fish species in Trinity, Shasta, and other export service area reservoirs are considered **potentially beneficial**.

Reservoir Warmwater Fish Species

Reservoir warmwater fish species habitat conditions would be similar or more suitable under Alternative B, relative to Existing Conditions, in Trinity and Shasta reservoirs because fewer water surface elevation reductions of six feet or more would occur during the warmwater fish nesting season. Therefore, fewer nest dewatering events would be anticipated. Water surface elevation reductions of six feet or more would occur with similar frequencies in Oroville and Folsom reservoirs. Therefore, habitat conditions for warmwater fish species are anticipated to be similar in Oroville and Folsom reservoirs. Habitat conditions in San Luis Reservoir are anticipated to be slightly less suitable because of increased frequencies of water surface elevation reductions of six feet or more, while increases in exports more often are anticipated to increase habitat suitability for warmwater fish species inhabiting other export service area reservoirs.

Therefore, for Alternative B, relative to Existing Conditions, potential impacts on reservoir warmwater fish species in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs are considered less than

significant, and impacts to warmwater fish species in other export service area reservoirs are considered **potentially beneficial**.

Central Valley Fall-Run Chinook Salmon

In general, during periods when fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative B, relative to Existing Conditions. Habitat conditions would be similar to those discussed under Alternative A, relative to Existing Conditions, except that conditions for fall-run Chinook salmon in the Sacramento River would be similar instead of similar/more suitable due to reduced spawning habitat availability. Habitat conditions in the American River would be substantially less suitable during all life stages (see Appendix 12C for a detailed discussion). Specifically, decreased flows and increased water temperatures, as well as increased early life stage mortality, would occur more frequently as a result of implementation of Alternative B.

Overall, under Alternative B, relative to Existing Conditions, potential operational impacts on fall-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**. On the American River under Alternative B relative to Existing Conditions, impacts on fall-run Chinook salmon would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative B, the potential operational impacts on fall-run Chinook salmon are considered to be **less than significant**.

Green Sturgeon

In general, during periods when green sturgeon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative B, relative to Existing Conditions. Habitat conditions would be generally similar to those described under Alternative A, relative to Existing Conditions, except that habitat conditions in the Trinity River would be considered similar instead of similar/more suitable due to similar flow and water temperature conditions. Habitat conditions in the American River would be substantially less suitable during all green sturgeon life stages due to decreased flows more often and increased water temperatures occurring with similar or higher frequencies, particularly during low flow conditions. Habitat conditions in the Yolo Bypass also would be less suitable for juvenile rearing and emigration as a result of decreased frequency of inundation (as identified by reduced Yolo Bypass outflow more often), and potentially reduced Delta productivity as a result of decreased Yolo Bypass inundation frequency (see Appendix 12C for a detailed discussion).

Overall, under Alternative B, relative to Existing Conditions, potential operational impacts on green sturgeon in the Trinity River, Sacramento River, Feather River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on green sturgeon in the Yolo Bypass are considered **potentially significant**. On the American River under Alternative B relative to Existing Conditions, impacts on green sturgeon would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative B, the potential operational impacts on green sturgeon are considered to be **less than significant**.

California Roach

Within the Secondary Study Area, during periods when roach are present in the Sacramento, Feather and American rivers, habitat conditions generally would be similar under Alternative B, relative to Existing Conditions. Habitat conditions would be generally similar to those discussed under Alternative A relative to Existing Conditions, except that habitat conditions in the Feather River would be similar or less suitable instead of similar, due to reduced flows more often during the spawning period. Habitat conditions in Clear Creek would be similar during most years, but would be more suitable for spawning during low flow conditions as a result of increased flows occurring more often. Habitat conditions for roach within the Level 4 refuges in the Extended Study Area are anticipated to be similar under Alternative B, relative to Existing Conditions.

Overall, under Alternative B, relative to Existing Conditions, potential operational impacts on California roach in the Sacramento River, Clear Creek, Feather River, and American River and Level 4 refuges are considered **less than significant**.

Sacramento Splittail

In general, during periods when splittail are present in the evaluated water bodies, habitat conditions would be similar under Alternative B, relative to the Existing Condition in the Sutter Bypass, and similar or less suitable in the Feather and American rivers. Habitat conditions in the Feather and American rivers would be slightly less suitable for spawning due to decreased flows and reduced useable flooded area occurring slightly more often. The reduction in usable flooded area slightly more often is not anticipated to result in a substantial impact to splittail in the Feather and American rivers. Habitat conditions for splittail within the Level 4 refuges in the Extended Study Area are anticipated to be similar under Alternative B, relative to Existing Conditions. However, reduced flows into and out of the Yolo Bypass would result in substantially less suitable habitat conditions for splittail spawning. Because of the importance of the Yolo Bypass to splittail population abundance, reduced floodplain inundation in the Yolo Bypass would constitute a substantial impact (see Appendix 12C for a detailed discussion).

Therefore, under Alternative B, relative to Existing Conditions, potential operational impacts on splittail in the Feather River, American River, Sutter Bypass, Delta, and Level 4 refuges are considered **less than significant**, and impacts on splittail in the Yolo Bypass are considered **potentially significant**.

Ecosystem Enhancement Storage Account and Ecosystem Enhancement Fund

Refer to the EESA and EEF discussions for Alternative A relative to Existing Conditions. That discussion applies to all three action alternatives.

12.3.8.2 Primary Study Area – Alternative B Relative to Existing Conditions

Construction, Operation, and Maintenance Impacts

The following Primary Study Area Project facilities are included in both Alternatives A and B. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts to aquatic biological resources:

- Sites Reservoir Inlet/Outlet Structure
- Sites Pumping/Generating Plant
- Holthouse Reservoir Complex

- GCID Canal Facilities Modifications
- TRR to Funks Creek Pipeline
- Delevan Pipeline

The Alternative B saddle dam access roads included in the Road Relocations and South Bridge feature would differ from Alternative A, but Eastside Road would have the same alignment over Funks Creek and would require the same construction, operation, and maintenance activities that were described for Alternative A. It would, therefore, have the same impacts on fish species of primary management concern (**Impact Fish-1**) as described for Alternative A.

The Alternative B Sites Reservoir would require the construction of two more saddle dams than the Alternative A reservoir. However, these additional saddle dams would not be located within or adjacent to a waterway. The Alternative B dams would therefore have the same impacts on fish species of primary management concern (**Impact Fish-1**) as described for Alternative A.

The boundary of the Project Buffer would be the same for Alternatives A and B, but because the footprints of some of the Project facilities that are surrounded by the Project Buffer would differ between the alternatives, the acreage of land within the Project Buffer would also differ. However, this difference in the size of the area included within the buffer would not change the type of construction, operation, and maintenance activities that were described for Alternative A. It would, therefore, have the same impacts on fish species of primary management concern (**Impact Fish-1**) as described for Alternative A.

The Alternative B Sites Reservoir would be larger than the Alternative A reservoir. In addition, Alternative B would replace the Delevan Pipeline Intake Facilities with the smaller Delevan Pipeline Discharge Facility. Potential impacts to aquatic biological resources associated with these proposed Project features that would differ from Alternative A are discussed below.

Sites Reservoir Inundation Area

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Aquatic Habitat Modification

Construction of a larger Sites Reservoir would have similar potential impacts to aquatic biological resources as discussed for Alternative A, except that construction of Sites Reservoir (1.81 MAF under Alternative B vs. 1.27 MAF under Alternative A) would eliminate and inundate approximately four miles of Stone Corral Creek and seven miles of Funks Creek upstream of the Sites Reservoir dams, compared to 3.9 miles of Stone Corral Creek and 6.5 miles of Funks Creek under Alternative A. Aquatic habitat removal and modification, specifically the inundation of Funks and Stone Corral creeks associated with the construction of Sites Reservoir, would result in a **potentially significant impact** to fish species of primary management concern.

Delevan Pipeline Discharge Facility

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified

as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Hydrostatic Pressure Waves, Noise and Vibration

Under Alternative B a cofferdam would be constructed in the Sacramento River along the entire length of the discharge facility (approximately 350 feet in length) and subsequently dewatered to allow for construction of the facility. Potential impacts to fisheries resources associated with the coffer dam construction would be similar to those discussed for the Delevan Pipeline Intake Facilities under Alternative A and could, therefore, result in a **potentially significant impact** to fish species of primary management concern.

Predation Risk

Potential impacts to fisheries resources associated with predation risk during construction, operation, and maintenance of the discharge facility would be similar to those discussed for the intake facilities under Alternative A. However, because Alternative B would only include a discharge facility without diversion capabilities, the facility footprint would be smaller than the intake facility under Alternative A. This smaller footprint would reduce the amount of riparian and aquatic habitat impacted, and therefore, reduce the potential for non-native predatory fish habitat creation. Despite the reduced potential in comparison to Alternative A, increased predation risk associated with the construction of this facility could have a **potentially significant** impact on fish species of primary management concern.

Aquatic Habitat Modification

The footprint of the smaller discharge facility is estimated to displace approximately 1.5 acres of Fremont Cottonwood riparian habitat that may act as SRA habitat, and approximately 0.1 acre of Valley Foothill Riparian habitat (compared to 1.1 acres and 0.5 acre of Fremont Cottonwood and Valley Foothill Riparian habitat types, respectively, under Alternative A), which may act as a source of IWM inputs to the Sacramento River. The removal of SRA habitat would result in a **potentially significant impact** to fish species of primary management concern in the Sacramento River.

Changes to Sacramento River Water Temperature

Water release temperatures from Sites Reservoir through the Delevan Pipeline Discharge Facility are expected to be the same as described for the Delevan Pipeline Intake Facilities and are therefore considered to be **less than significant**.

12.3.9 Impacts Associated with Alternative B Relative to the No Project/No Action Alternative

Potential impacts on fish species of primary management concern associated with implementation of Alternative B, relative to the No Project/No Action Alternative, were evaluated in an identical manner to those described for the No Project/No Action Alternative, relative to Existing Conditions. Specifically, model results and locations evaluated were identical among alternatives.

A summary of changes in habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the export service area under Alternative B, relative to the No Project/No Action Alternative, is presented in Table 12-21. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas under Alternative B, relative to the No Project/No Action Alternative, is presented in Table 12-22. Species-specific

summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.9.1 Extended and Secondary Study Areas - Alternative B Relative to the No Project/No Action Alternative

The impacts associated with Alternative B relative to the No Project/No Action Alternative, as they relate to fish species of primary management concern (**Impact Fish-1**), would be the same as described for Alternative A relative to the No Project/No Action Alternative for the following species within the Extended and Secondary study areas:

- Klamath Mountains Province steelhead
- Sacramento River winter-run Chinook salmon
- Central Valley fall-run Chinook salmon
- Central Valley late fall-run Chinook salmon
- White sturgeon
- Pacific lamprey
- River lamprey
- Hardhead
- California roach
- Delta smelt
- Longfin smelt
- Sacramento splittail
- Largemouth bass

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C. Construction-related impacts associated with implementation of Alternative B, relative to the No Project/No Action Alternative, on all fish species of primary management concern would be the same as those described for Alternative A relative to Existing Conditions. Operational impacts associated with Alternative B relative to the No Project/No Action Alternative that would differ from those described for Alternative A relative to the No Project/No Action Alternative are described below.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Reservoir coldwater fish species habitat conditions would be more suitable in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs under Alternative B, relative to the No Project/No Action Alternative.

Specifically, within the Secondary Study Area, end-of-month storage generally would be greater under Alternative B, relative to the No Project/No Action Alternative in each of the SWP/CVP reservoirs evaluated. Reservoir coldwater fish species habitat conditions would also be anticipated to be more suitable in export service area reservoirs due to generally increased SWP and CVP exports occurring more frequently and potentially resulting in increased storage in export service area reservoirs.

Therefore, for Alternative B, relative to the No Project/No Action Alternative, potential impacts on reservoir coldwater fish species in Trinity, Shasta, Oroville, Folsom, San Luis, and other export service area reservoirs are considered **potentially beneficial**.

Reservoir Warmwater Fish Species

Reservoir warmwater species habitat conditions would be similar or more suitable under Alternative B, relative to the No Project/No Action Alternative in Trinity and Shasta reservoirs because water surface elevation reductions of six feet or more during the warmwater fish nesting season would occur less frequently. Therefore, fewer nest dewatering events are anticipated. Water surface elevation reductions of six feet or more would be similar in Oroville, Folsom, and San Luis reservoirs. Therefore, impacts on reservoir warmwater fish species are anticipated to be similar. Reservoir warmwater fish species habitat conditions are anticipated to be more suitable in export service area reservoirs due to generally increased SWP and CVP exports that would occur more frequently and potentially result in increased littoral habitat in export service area reservoirs.

Therefore, for Alternative B, relative to the No Project/No Action Alternative, potential impacts on reservoir warmwater fish species in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs are considered **less than significant**, and impacts on warmwater fish species in other export service area reservoirs are considered **potentially beneficial**.

Southern Oregon/Northern California Coho Salmon

In general, simulated habitat conditions in the Trinity River would be similar under Alternative B, relative to the No Project/No Action Alternative (see Appendix 12C for a detailed discussion).

Therefore, under Alternative B, relative to the No Project/No Action Alternative, potential impacts on Coho salmon in the Trinity River are considered **less than significant**.

Upper Klamath-Trinity River Fall-Run and Spring-Run Chinook Salmon

In general, during the periods when Chinook salmon are present in the Trinity River, habitat conditions, as well as early life stage mortality, would be similar under Alternative B, relative to the No Project/No Action Alternative (see Appendix 12C for a detailed discussion).

Therefore, under Alternative B, relative to the No Project/No Action Alternative, potential impacts on spring-run and fall-run Chinook salmon in the Trinity River are considered **less than significant**.

Central Valley Spring-Run Chinook Salmon

In general, during periods when spring-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under Alternative B, relative to the No Project/No Action Alternative. However, habitat conditions in the Sacramento River and Clear Creek would be similar or more suitable. Specifically, in the Sacramento River, habitat conditions would be generally similar during most life stages, but flows would be higher and water temperatures would be lower more frequently during

spawning and embryo incubation. Additionally, these conditions would result in reduced early life stage mortality, reduced population mortality, and increased production potential. Habitat conditions in Clear Creek would be similar or more suitable because slightly lower water temperatures would occur more frequently (see Appendix 12C for a detailed discussion).

Overall, under Alternative B, relative to the No Action Alternative, potential operational impacts on spring-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**.

Central Valley Steelhead

In general, during periods when steelhead are present in the evaluated water bodies, habitat conditions would be similar under Alternative B, relative to the No Project/No Action Alternative. However, habitat conditions in the American River would be similar or more suitable because flows would be increased more frequently during most life stages. Additionally, spawning habitat availability would be greater in the American River under Alternative B, relative to the No Project/No Action Alternative. However, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing and emigration, as a result of decreased frequency of inundation (as identified by reduced Yolo Bypass outflow), and potentially reduced Delta productivity as a result of decreased Yolo Bypass inundation frequency (see Appendix 12C for a detailed discussion).

Overall, under Alternative B, relative to the No Action Alternative, potential operational impacts on steelhead in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on steelhead in the Yolo Bypass are considered **potentially significant**.

Green Sturgeon

In general, during periods when green sturgeon are present in the evaluated water bodies, habitat conditions would be similar under Alternative B, relative to the No Project/No Action Alternative. Additionally, habitat conditions in the Sacramento River would be generally similar or more suitable due to generally higher flows that would occur more often and occur more often during low flow conditions. However, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing due to a decreased frequency of floodplain activation, which results in reduced floodplain rearing opportunities and reduced nutrient inflow to the Delta and bays (see Appendix 12C for a detailed discussion).

Overall, under Alternative B, relative to the No Action Alternative, potential operational impacts on green sturgeon in the Trinity River, Sacramento River, Feather River, American River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on green sturgeon in the Yolo Bypass are considered **potentially significant**.

Striped Bass

In general, during periods when striped bass are present in the evaluated water bodies, habitat conditions would be similar under Alternative B, relative to the No Project/No Action Alternative. However, habitat conditions in the American River would be similar or more suitable due to increased flows that would occur more frequently during most months of all life stages, although reduced flows would occur more frequently (see Appendix 12C for a detailed discussion).

Therefore, for Alternative B, relative to the No Project/No Action Alternative, potential impacts on striped bass in the Sacramento River, Feather River, American River, Delta, and bays are considered **less than significant**.

American Shad

Operations-related impacts on American shad would be similar to those described for striped bass under Alternative B, relative to the No Project/No Action Alternative, and are considered **less than significant**.

12.3.9.2 Primary Study Area – Alternative B Relative to the No Project/No Action Alternative

Construction, Operation, and Maintenance Impacts

Refer to the **Impact Fish-1** Primary Study Area discussion for Alternative B relative to Existing Conditions. That discussion also applies to Alternative B relative to the No Project/No Action Alternative.

12.3.10 Impacts Associated with Alternative C Relative to Existing Conditions

Potential impacts on fish species of primary management concern associated with implementation of Alternative C, relative to Existing Conditions, were evaluated in an identical manner to those described for Alternative A, relative to Existing Conditions. Specifically, model results and locations evaluated were identical among alternatives.

A summary of changes in habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the export service area under Alternative C, relative to Existing Conditions, is presented in Table 12-23. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas under Alternative C, relative to Existing Conditions, is presented in Table 12-24. Species-specific summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.10.1 Extended and Secondary Study Areas - Alternative C Relative to Existing Conditions

The impacts associated with Alternative C relative to Existing Conditions, as they relate to fish species of primary management concern (**Impact Fish-1**), would be the same as described for Alternative A relative to Existing Conditions for the following species within the Extended and Secondary study areas:

- Southern Oregon / Northern California Coho
- Upper Klamath / Trinity fall and spring-run Chinook salmon
- Klamath Mountains Province steelhead
- Central Valley steelhead
- Green sturgeon
- White sturgeon
- Pacific lamprey
- River lamprey
- Hardhead
- California Roach
- Delta smelt
- Longfin smelt

- Striped bass
- American shad
- Largemouth bass

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C**.** Construction-related impacts associated with implementation of Alternative C, relative to Existing Conditions, on all fish species of primary management concern would be the same as those described for Alternative A relative to Existing Conditions. Operational impacts associated with Alternative C relative to Existing Conditions that would differ from those described for Alternative A, relative to Existing Conditions, are described below.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Reservoir coldwater fish species habitat conditions would be similar or more suitable in Trinity, Shasta and Oroville reservoirs under Alternative C, relative to Existing Conditions, due to generally higher reservoir storages that would occur more often. Coldwater fisheries habitat conditions would be generally similar to conditions under Alternative A relative to Existing Conditions, except that conditions would be similar or more suitable in Folsom Reservoir instead of more suitable, due to more similar reservoir storages. Habitat conditions would be similar or less suitable in San Luis Reservoir, and more suitable in export service area reservoirs due to reduced storage that would occur more often in San Luis Reservoir and potentially increased storage in other export service area reservoirs due to increased SWP/CVP exports.

Therefore, for Alternative C, relative to Existing Conditions, potential impacts on reservoir coldwater fish species in Oroville, Folsom, and San Luis reservoirs are considered **less than significant**, and impacts on coldwater fish species in Trinity, Shasta, and other export service area reservoirs are considered **potentially beneficial**.

Reservoir Warmwater Fish Species

Reservoir warmwater species habitat conditions would be similar or more suitable under Alternative C, relative to Existing Conditions, in Trinity and Shasta reservoirs because fewer water surface elevation reductions of six feet or more would occur during the warmwater fish nesting season. Therefore, fewer nest dewatering events would be anticipated. Warmwater fisheries habitat conditions would be similar to conditions under Alternative A, relative to Existing Conditions, except that conditions in Shasta Lake would be more suitable instead of similar or more suitable, due to reduced water surface elevation

reductions. Simulated water surface elevation reductions of six feet or more would occur with similar frequency in Oroville Reservoir, and would occur with slightly higher frequencies in Folsom Reservoir. Therefore, habitat conditions for warmwater species are anticipated to be similar in Oroville Reservoir and slightly less suitable in Folsom Reservoir. Habitat conditions in San Luis Reservoir are anticipated to be slightly less suitable because of expected increased frequencies of water surface elevation reductions of six feet or more, while increases in exports that would occur more often are anticipated to increase habitat suitability for warmwater species inhabiting other export service area reservoirs.

Therefore, for Alternative C, relative to Existing Conditions, potential impacts on reservoir warmwater fish species in Trinity, Oroville, Folsom, and San Luis reservoirs are considered **less than significant**, and impacts on warmwater fish species in Shasta and other export service area reservoirs are considered **potentially beneficial**.

Sacramento River Winter-Run Chinook Salmon

In general, during periods when winter-run Chinook salmon are present in the Sutter Bypass, Delta, and bays downstream of the Delta, habitat conditions would be similar or more suitable under Alternative A, relative to Existing Conditions. Habitat conditions in the Sacramento River would be generally more suitable as a result of more suitable spawning and embryo incubation conditions that would occur more often, while habitat conditions in the Delta would be more suitable due to generally higher juvenile survival that would occur more often through the Delta (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to Existing Conditions, potential operational impacts on winter-run Chinook salmon in the Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**, and impacts on winter-run Chinook salmon in the Sacramento River are considered **potentially beneficial**.

Central Valley Spring-Run Chinook Salmon

In general, during periods when spring-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar or more suitable under Alternative C, relative to Existing Conditions, due to increased flows that would occur more often and reduced water temperatures that would occur more often. Habitat conditions under Alternative C would be similar to conditions under Alternative A relative to Existing Conditions, except that conditions in the Sacramento River are considered similar or more suitable instead of more suitable, due to slightly less suitable flows and water temperatures during October. In addition, Delta habitat conditions are considered similar under Alternative C instead of similar or more suitable under Alternative A relative to Existing Conditions, due to generally similar through Delta survival. Habitat conditions in the American River for non-natal juvenile spring-run Chinook salmon would be generally similar or slightly less suitable due to reduced flows that would occur more frequently under Alternative C, relative to Existing Conditions. However, it is not anticipated that these habitat conditions would substantially affect spring-run Chinook salmon, particularly because the American River only supports non-natal juvenile rearing (see Appendix 12C for a detailed discussion).

Overall, under Alternative C, relative to Existing Conditions, potential operational impacts on spring-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**.

Central Valley Fall-Run Chinook Salmon

In general, during periods when fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be generally similar or more suitable under Alternative C, relative to Existing Conditions. Habitat conditions would be similar to those discussed under Alternative A relative to Existing Conditions, except that conditions for fall-run Chinook salmon in the Sacramento River would be considered similar instead of similar or more suitable due to reduced spawning habitat availability. Habitat conditions in the American River would be substantially less suitable during all life stages (see Appendix 12C for a detailed discussion). Specifically, decreased flows and increased water temperatures, as well as increased early life stage mortality, would occur more frequently as a result of implementation of Alternative C.

Overall, under Alternative C, relative to Existing Conditions, potential operational impacts on fall-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**. On the American River under Alternative C relative to Existing Conditions, impacts on fall-run Chinook salmon would be considered potentially significant. However, these impacts would occur with or without implementation of the proposed Project and are therefore not considered to be Project-related impacts. Because these adverse changes in flows and temperatures would not be caused by implementation of Alternative C, the potential operational impacts on fall-run Chinook salmon are considered to be **less than significant**.

Sacramento Splittail

In general, during periods when splittail are present in the evaluated water bodies, habitat conditions would be generally similar under Alternative C, relative to Existing Conditions in the Sutter Bypass, and would be similar or less suitable in the Feather and American rivers. Habitat conditions in the Feather and American rivers would be slightly less suitable for spawning due to decreased flows and reduced useable flooded area that would occur slightly more often. The reduction in usable flooded area that would occur slightly more often is not anticipated to result in a substantial impact to splittail in the Feather and American rivers. Habitat conditions for splittail within the Level 4 refuges in the Extended Study Area are anticipated to be similar under Alternative C, relative to Existing Conditions. However, reduced flows into and out of the Yolo Bypass would result in substantially less suitable habitat conditions for splittail spawning. Because of the importance of the Yolo Bypass to splittail population abundance, reduced floodplain inundation in the Yolo Bypass would constitute a substantial impact (see Appendix 12C for a detailed discussion).

Therefore, under Alternative C, relative to Existing Conditions, potential operational impacts on splittail in the Feather River, American River, Sutter Bypass, Delta, and Level 4 refuges are considered **less than significant**, and impacts on splittail in the Yolo Bypass are considered **potentially significant**.

Ecosystem Enhancement Storage Account and Ecosystem Enhancement Fund

Refer to the EESA and EEF discussions for Alternative A relative to Existing Conditions. That discussion applies to all three action alternatives.

12.3.10.2 Primary Study Area – Alternative C Relative to Existing Conditions

Construction, Operation, and Maintenance Impacts

The following Primary Study Area Project facilities are included in Alternatives A, B, and C. These facilities would require the same construction methods and operation and maintenance activities regardless of alternative, and would, therefore, result in the same construction, operation, and maintenance impacts to aquatic biological resources:

- Sites Reservoir Inlet/Outlet Structure
- Sites Pumping/Generating Plant
- Holthouse Reservoir Complex
- GCID Canal Facilities Modifications
- TRR to Funks Creek Pipeline
- Delevan Pipeline

The Alternative C Road Relocations and South Bridge feature would include the same alignment of Eastside Road over Funks Creek as Alternative A. Therefore, the impacts of the road relocations on fish species of primary management concern (**Impact Fish-1**) would be the same as described for Alternative A.

The Alternative C Sites Reservoir Inundation Area and Sites Dams would be the same as the Alternative B reservoir and dams. The Alternative C reservoir and dams would therefore have the same impacts on fish species of primary management concern (**Impact Fish-1**) as described for Alternative B.

The Delevan Pipeline Intake Facilities included in Alternative C would be the same as the Alternative A intake facilities. Therefore, the impacts of the intake facilities on fish species of primary management concern (**Impact Fish-1**) would be the same as described for Alternative A.

The boundary of the Project Buffer would be the same for Alternatives A, B, and C, but because the footprints of some of the Project facilities that are surrounded by the Project Buffer would differ between the alternatives, the acreage of land within the Project Buffer would also differ. However, this difference in the size of the area included within the buffer would not change the type of construction, operation, and maintenance activities that were described for Alternative A. It would, therefore, have the same impacts on fish species of primary management concern (**Impact Fish-1**) as described for Alternative A.

12.3.11 Impacts Associated with Alternative C Relative to the No Project/No Action Alternative

Potential impacts on fish species of primary management concern associated with implementation of Alternative C, relative to the No Project/No Action Alternative, were evaluated in an identical manner to those described for the No Project/No Action Alternative, relative to Existing Conditions. Specifically, model results and locations evaluated were identical among alternatives.

A summary of changes in habitat conditions in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs, as well as reservoirs in the export service area under Alternative C, relative to the No Project/No Action Alternative, is presented in Table 12-25. A summary of the changes in habitat conditions associated with riverine, estuarine, and floodplain habitats in the Extended and Secondary study areas under Alternative C, relative to the No Project/No Action Alternative, is presented in Table 12-26. Species-specific

summary discussions of the information presented in these tables are provided below to support significance determinations.

12.3.11.1 Extended and Secondary Study Areas - Alternative C Relative to the No Project/No Action Alternative

The impacts associated with Alternative C relative to the No Project/No Action Alternative, as they relate to fish species of primary management concern (**Impact Fish-1**), would be the same as described for Alternative A relative to the No Project/No Action Alternative for the following species within the Extended and Secondary study areas:

- Southern Oregon/Northern California Coho salmon
- Upper Klamath-Trinity River fall-run and spring-run Chinook salmon
- Klamath Mountains Province steelhead
- Sacramento River winter-run Chinook salmon
- Central Valley late fall-run Chinook salmon
- White sturgeon
- Pacific lamprey
- River lamprey
- Hardhead
- California roach
- Delta smelt
- Longfin smelt
- Striped bass
- American shad
- Largemouth bass

Refer to the Alternative B discussion for Central Valley steelhead relative to the No Project/No Action Alternative. That discussion also applies to Central Valley steelhead under Alternative C, relative to the No Project/No Action Alternative.

Detailed discussion of potential impacts and aquatic habitat conditions in the Extended and Secondary study areas is provided in Appendix 12C. Construction-related impacts associated with implementation of Alternative C, relative to the No Project/No Action Alternative, on all species of primary management concern would be the same as those described for Alternative A relative to Existing Conditions. Operational impacts associated with Alternative C relative to the No Project/No Action Alternative that would differ from those described for Alternative A, relative to the No Project/No Action Alternative, are described below.

Construction, Operation, and Maintenance Impacts

Wildlife Refuge Water Use, San Luis Reservoir, Export Service Area Reservoirs, Trinity Lake, Lewiston Lake, Trinity River, Klamath River downstream of the Trinity River, Spring Creek, Shasta Lake, Sacramento River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, American River, Sacramento-San Joaquin Delta, Suisun Bay, San Pablo Bay, and San Francisco Bay

Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish

nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.

Reservoir Coldwater Fish Species

Reservoir coldwater fish species habitat conditions would be more suitable in Trinity, Shasta, Folsom, and San Luis reservoirs, and similar or more suitable in Oroville Reservoir under Alternative C, relative to the No Project/No Action Alternative. Specifically, within the Secondary Study Area, end-of-month storage generally would be greater under Alternative C, relative to the No Project/No Action Alternative in each of the SWP/CVP reservoirs evaluated. Reservoir coldwater fish species habitat conditions also are anticipated to be more suitable in export service area reservoirs due to generally increased SWP and CVP exports that would occur more frequently and potentially result in increased storage in export service area reservoirs. However, reservoir coldwater fish species habitat in San Luis Reservoir would be less suitable as a result of net storage decreases of 10 percent or more that would occur more often under Alternative C, relative to the No Project/No Action Alternative.

Therefore, for Alternative C, relative to the No Project/No Action Alternative, potential impacts on reservoir coldwater fish species in Oroville Reservoir are considered **less than significant;** impacts on coldwater fish species in Trinity, Shasta, Folsom, and other export service area reservoirs are considered **potentially beneficial;** and impacts on coldwater fish species in San Luis Reservoir are considered **potentially significant**.

Reservoir Warmwater Fish Species

Reservoir warmwater fish species habitat conditions would be similar or more suitable under Alternative C, relative to the No Project/No Action Alternative in Trinity and Shasta reservoirs because water surface elevation reductions of six feet or more during the warmwater fish nesting season would occur less frequently. Therefore, fewer nest dewatering events are anticipated. Water surface elevation reductions of six feet or more would be similar in Oroville and Folsom reservoirs. Therefore, impacts on reservoir warmwater fish species are anticipated to be similar. Reservoir warmwater fish species habitat conditions are anticipated to be more suitable in export service area reservoirs due to generally increased SWP and CVP exports that would occur more frequently and potentially result in increased littoral habitat in export service area reservoirs. However, San Luis Reservoir warmwater fish species habitat would be similar or less suitable due to reservoir water surface elevation reductions of six feet or more that would occur more frequently.

Therefore, for Alternative C, relative to the No Project/No Action Alternative, potential impacts on reservoir warmwater fish species in Trinity, Shasta, Oroville, Folsom, and San Luis reservoirs are considered **less than significant,** and impacts on warmwater fish species in other export service area reservoirs are considered **potentially beneficial**.

Central Valley Spring-Run Chinook Salmon

In general, during periods when spring-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under Alternative C, relative to the No Project/No Action Alternative. However, habitat conditions in the Sacramento River and Clear Creek would be similar or more suitable. Specifically, in the Sacramento River, habitat conditions would be generally similar during most life stages, but flows would be higher and water temperatures would be lower more frequently during

spawning and embryo incubation. Additionally, these conditions would result in reduced early life stage mortality, reduced population mortality, and increased production potential. Habitat conditions in the American River would be similar or more suitable because higher flows and lower temperatures generally would occur more frequently. Habitat conditions in Clear Creek would be similar or more suitable due to slightly lower water temperatures that would occur more frequently (see Appendix 12C for a detailed discussion).

Overall, under Alternative C, relative to the No Action Alternative, potential operational impacts on spring-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, American River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**.

Central Valley Fall-Run Chinook Salmon

In general, during periods when fall-run Chinook salmon are present in the evaluated water bodies, habitat conditions would be similar under Alternative C, relative to the No Project/No Action Alternative. However, simulated habitat conditions in Clear Creek would be similar or more suitable because slightly decreased water temperatures would occur during spawning. Habitat conditions in the American River would be more suitable because of higher flows and lower temperatures that would occur more frequently (see Appendix 12C for a detailed discussion).

Overall, under Alternative C, relative to the No Action Alternative, potential operational impacts on fall-run Chinook salmon in the Sacramento River, Clear Creek, Feather River, Sutter Bypass, Yolo Bypass, Delta, and bays are considered **less than significant**, and impacts on fall-run Chinook salmon in the American River are considered **potentially beneficial**.

Green Sturgeon

In general, during periods when green sturgeon are present in the evaluated water bodies, habitat conditions would be similar under Alternative C, relative to the No Project/No Action Alternative. Additionally, habitat conditions in the Sacramento River would be generally similar or more suitable due to generally similar spawning conditions, but higher flows would occur more often in the lower reaches of the river during adult immigration, and higher flows would occur more often during low flow conditions during juvenile emigration. However, habitat conditions in the Yolo Bypass would be less suitable for juvenile rearing due to a decreased frequency of floodplain activation, which would result in reduced floodplain rearing opportunities and reduced nutrient inflow to the Delta and bays (see Appendix 12C for a detailed discussion).

Overall, under Alternative C, relative to the No Action Alternative, potential operational impacts on green sturgeon in the Trinity River, Sacramento River, Feather River, American River, Sutter Bypass, Delta, and bays are considered **less than significant**, and impacts on green sturgeon in the Yolo Bypass are considered **potentially significant**.

Sacramento Splittail

In general, during periods when splittail are present in the evaluated water bodies, habitat conditions would be similar under Alternative C, relative to the No Project/No Action Alternative. However, reduced flows into and out of the Yolo Bypass would result in less suitable habitat conditions for splittail spawning. Because of the importance of the Yolo Bypass to splittail population abundance, reduced floodplain inundation in the Yolo Bypass would constitute a substantial impact (see Appendix 12C for a detailed discussion).

Overall, under Alternative A, relative to the No Project/No Action Alternative, potential operational impacts on splittail in the Feather River, American River, Sutter Bypass, Delta, and Level 4 wildlife refuges are considered **less than significant**, and impacts on splittail in the Yolo Bypass are considered **potentially significant**.

12.3.11.2 Primary Study Area – Alternative C Relative to the No Project Alternative

Construction, Operation, and Maintenance Impacts

Refer to the **Impact Fish-1** Primary Study Area discussion for Alternative C relative to Existing Conditions. That discussion also applies to Alternative C relative to the No Project/No Action Alternative.

12.4 Mitigation Measures

Mitigation measures are provided below and summarized in Table 12-27 for the impacts that have been identified as significant or potentially significant.

Table 12-27
Summary of Mitigation Measures for
NODOS Project Impacts to Aquatic Biological Resources

Impact	Associated Project Facility	LOS Before Mitigation	Mitigation Measure	LOS After Mitigation
Impact Fish-1: A substantial adverse effect (either directly, through habitat modifications, by interfering with the movement of native fish species, or by impeding the use of native fish nursery/rearing sites) on any fish species of primary management concern, including species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFG, NMFS or USFWS.				
Impact Fish-1a: Temperature Effects	San Luis Reservoir (Alternative C compared to the No Project/No Action Alternative for coldwater fish species)	Potentially Significant	Mitigation Measure Fish-1a: Increase stocking frequency of coldwater fish species.	Less than Significant
Impact Fish-1b: Reduced Flows	Yolo Bypass (all alternatives)	Potentially Significant	Mitigation Measure Fish-1b: Prepare and Implement a Mitigation Monitoring and Reporting Plan	Less than Significant

Table 12-27
Summary of Mitigation Measures for
NODOS Project Impacts to Aquatic Biological Resources

Impact	Associated Project Facility	LOS Before Mitigation	Mitigation Measure	LOS After Mitigation
Impact Fish-1c: Erosion, Sedimentation and Turbidity	Sites Reservoir Inundation Area, Sites Dams, Road Relocations and South Bridge, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Holthouse Reservoir Complex, GCID Canal Facilities Modifications, TRR to Funks Creek Pipeline, Delevan Pipeline, Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility, Project Buffer	Potentially Significant	Mitigation Measure Fish-1c: Prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) and an Erosion and Sediment Control Plan (ESCP) prior to the initiation of construction activities.	Less than Significant
Impact Fish-1d: Hazardous Materials and Chemical Spills	Sites Reservoir Inundation Area, Sites Dams, Road Relocations and South Bridge, Sites Reservoir Inlet/Outlet Structure, Sites Pumping/Generating Plant, Holthouse Reservoir Complex, GCID Canal Facilities Modifications, TRR to Funks Creek Pipeline, Delevan Pipeline, Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility	Potentially Significant	Mitigation Measure Fish-1c: Prepare and Implement a Stormwater Pollution Prevention Plan (SWPPP) and an Erosion and Sediment Control Plan (ESCP) Prior to the initiation of Construction Activities.	Less than Significant
			Mitigation Measure Fish-1d: Prepare and Implement a Spill Prevention and Hazardous Materials Management Plan Prior to the Initiation of Construction Activities.	

Table 12-27
Summary of Mitigation Measures for
NODOS Project Impacts to Aquatic Biological Resources

Impact	Associated Project Facility	LOS Before Mitigation	Mitigation Measure	LOS After Mitigation
Impact Fish-1e: Aquatic Habitat Modification	Sites Reservoir Inundation Area, Sites Dams, Sites Reservoir Inlet/Outlet Structure, /Sites Pumping/Generating Plant, Holthouse Reservoir Complex, Delevan Pipeline, Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility	Potentially Significant	Mitigation Measure Fish-1e: Implement Habitat Restoration Actions	Less than Significant
Impact Fish-1f: Hydrostatic Pressure Waves, Noise, and Vibration	Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility	Potentially Significant	Mitigation Measure Fish-1f: Perform In-Water Pile Driving July Through September During Daylight Hours.	Less than Significant
Impact Fish-1g: Predation Risk	Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility, Delevan Pipeline Discharge Facility	Potentially Significant	Mitigation Measure Fish-1g: Design Fish Screen in Compliance with NMFS and CDFG Criteria	Less than Significant
Impact Fish-1h: Stranding, Impingement, and Entrainment	Delevan Pipeline Intake Facilities, Delevan Pipeline Discharge Facility	Potentially Significant	Mitigation Measure Fish-1h: Prepare and Implement a Fish Salvage and Rescue Plan	Less than Significant

Mitigation Measure Fish-1a: Increase stocking frequency of coldwater fish species.

[Text to be developed]

Mitigation Measure Fish-1b: Prepare and Implement a Mitigation Monitoring and Reporting Plan

DWR and Reclamation shall prepare and implement a Mitigation Monitoring and Reporting Plan to mitigate for expected significant reduced flows through the Yolo Bypass (all alternatives), which could include the following mitigation measure:

- Modifications to the Fremont Weir to allow additional flow for inundation of the Yolo Bypass has been identified as a fisheries habitat improvement action by other projects or programs and may be implemented before the NODOS Project is authorized. If modifications occur before implementation of the NODOS Project, this impact would be reduced to less than significant and would not require mitigation. If the modifications are not yet implemented, mitigation measures for the NODOS Project could include modification of the weir to offset potentially reduced flows through the Yolo Bypass and associated habitat availability for splittail and other fish species of primary management concern.

Mitigation Measure Fish-1c: Prepare and Implement a Stormwater Pollution Prevention Plan (SWPPP) and an Erosion and Sediment Control Plan (ESCP) Prior to the Initiation of Construction Activities.

DWR and Reclamation shall prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) and an Erosion and Sediment Control Plan (ESCP) prior to the initiation of construction activities. The SWPPP and/or ESCP shall incorporate Central Valley Regional Water Quality Control Board's dewatering requirements and the California Storm Water Quality Association's best management practices for dewatering, and shall establish site-specific erosion- and sediment-control measures for construction, operation, and maintenance activities, such as:

- Minimizing traffic speeds on access roads to 10 miles per hour or less.
- Maintaining a minimum of two feet of freeboard on all haul trucks.
- Periodically applying water to disturbed areas, to control dust exposure as needed, depending on weather conditions.
- Applying soil stabilizers in accordance with manufacturers' specifications to all inactive construction areas.
- Installing erosion control wattles around all disturbed areas and ditches.
- Installing silt fencing.
- Utilizing drainage inlet protection.
- Utilizing sediment settling basins through which all water removed from any waterways will be pumped into prior to being discharged into any waterways.
- Utilizing concrete washout areas.
- Hydroseeding and mulching disturbed areas.

Mitigation Measure Fish-1d: Prepare and Implement a Spill Prevention and Hazardous Materials Management Plan Prior to the Initiation of Construction Activities.

DWR and Reclamation shall prepare a Spill Prevention and Hazardous Materials Management Plan (developed as part of the SWPPP) that would be designed to minimize the potential for chemical spills and seepage during construction, operation, and maintenance activities. Such a plan may include, but not be limited to, the following:

- On-site handling rules to keep construction and maintenance materials out of drainages and waterways;
- Prevention of any substances that could be hazardous to aquatic life from contaminating the soil or entering watercourses, including ditches and canals;
- Cleaning up all spills immediately according to the spill prevention and control plan, and notifying CDFG and the Central Valley Regional Water Quality Control Board (CVRWQCB) immediately of spills and associated cleanup procedures;

- Providing staging and storage areas away from watercourses and their watersheds for equipment, materials, fuels, lubricants, solvents, and other possible contaminants
- Publishing protocols for regular maintenance of construction vehicles and equipment to minimize the potential for leakage or spills.

Mitigation Measure Fish-1e: Implement Habitat Restoration Actions.

To minimize disturbance to aquatic habitat, construction personnel shall participate in an environmental awareness training program provided by a qualified biologist. Construction personnel shall be informed about any sensitive biological resources associated with the proposed Project and that disturbance of sensitive habitat or special-status species would be a violation of the Endangered Species Act and the Clean Water Act.

Mitigation specific to construction of the proposed Project facilities could include the following:

- **Construction of Sites Reservoir Inundation Area and Sites Dams**
  - Mitigation measures to offset inundation of Stone Corral and Funks creeks shall include habitat restoration of Stone Corral and Funks Creek at a ratio of 2:1 (i.e., two acres restored for every acre removed), such that twice as many linear stream miles would be restored along Stone Corral and Funks creeks as would be inundated by Sites Reservoir and displaced by Sites and Golden Gate dams. Habitat restoration actions may occur at other nearby creeks if feasible habitat restoration actions on Stone Corral and Funks creek are inadequate to meet mitigation requirements. Habitat restoration measures could include removal of non-native vegetation in the riparian area, planting of native riparian species, bank stabilization in areas with excessive erosion, and potentially active removal of non-native fish species. Monitoring of restoration actions shall be conducted for a minimum of five years to ensure that restored habitat is functioning as intended. Specific restoration actions and sites to be restored at each creek shall be included in the Mitigation Monitoring and Reporting Plan.
- **Construction of Holthouse Reservoir Complex, the Sites Reservoir Inlet/Outlet Structure, and the Sites Pumping/Generating Plant**
  - Mitigation measures shall include habitat restoration along Funks Creek at a ratio of 2:1, which shall be in addition to the number of stream miles restored associated with inundation of Funks Creek by Sites Reservoir. Habitat restoration actions may occur at other nearby creeks if feasible habitat restoration actions on Funks creek are inadequate to meet mitigation requirements. Monitoring of restoration actions shall be conducted for a minimum of five years to ensure that restored habitat is functioning as intended. Specific restoration actions and sites to be restored shall be included in the Mitigation Monitoring and Reporting Plan.
- **Construction of the Delevan Pipeline**
  - Construction activities associated with the Delevan Pipeline at Hunters Creek and the Colusa Basin Drain shall occur during the summer months when the water bodies generally are dry. If construction occurs during a particularly wet year when the water bodies do not cease flowing, construction shall occur in a manner that allows passage of native fishes past construction sites. Specifically, construction shall occur across only half of the water body at one time. Cofferdams shall be installed to isolate half of the total construction area, allowing the other half of the water body to remain flowing. After construction on one side of the water body is complete, the other half shall then be isolated and dewatered where construction shall continue.

- Measures to mitigate for the temporary loss of habitat on Hunters Creek and the Colusa Basin Drain shall include on-site habitat restoration following the completion of construction. Habitat restoration measures could include planting of native riparian species and removal of non-native vegetation. Monitoring of restoration actions shall be conducted for a minimum of five years to ensure that restored habitat is functioning as intended.

- **Construction of the Delevan Pipeline Intake Facilities and Delevan Pipeline Discharge Facility**

  - As mitigation for loss of riparian and SRA habitat on the Sacramento River, degraded habitat shall be restored to provide riparian and/or SRA habitat at or near the areas affected by construction of the intake/discharge facilities at a ratio of 2:1. Proposed restoration activities shall include the removal of non-native vegetation as necessary and re-vegetation with native riparian species to provide shaded riverine aquatic (SRA) and/or riparian habitat. As a component of SRA habitat, riparian tree species such as alders, cottonwoods and willows, shall be planted. In addition to habitat restoration actions, due to the importance of IWM to juvenile fishes in the Sacramento River, any IWM that is moved or altered by construction activities shall stay on-site and be returned to the river, or be replaced with a functional equivalent. Monitoring of restoration actions shall be conducted for a minimum of five years to ensure that restored habitat is functioning as intended. Specific restoration actions and sites to be restored on the Sacramento River shall be included in the Mitigation Monitoring and Reporting Plan.

Mitigation Measure Fish-1f: Perform In-Water Pile Driving July Through September During Daylight Hours.

In-water pile driving shall only occur during July through September during daylight hours. This time period takes into consideration the migratory patterns of salmonids; pile driving shall occur after the cessation of the outmigration of juvenile salmon and before the initiation of the upstream migration of adults returning to spawn. To avoid impacts to the majority of fish species of primary management concern, sheet pile installation and in-stream heavy equipment activity shall be coordinated with USFWS, USBR, CDFG, and NMFS to avoid and or minimize potential impacts. If feasible, a vibratory hammer shall be used, and pile driving shall commence at low energy levels and slowly build to impact force. In addition, underwater sound levels shall be monitored to ensure that pile driving activities do not create underwater sound levels that exceed NMFS' noise thresholds (i.e., accumulated sound exposure level of 183 dB and a peak pressure of 206 dB).

Mitigation Measure Fish-1g: Design Fish Screen in Compliance with NMFS and CDFG Criteria.

Fish screen at the Delevan Pipeline Intake Facilities shall be designed to comply with NMFS and CDFG fish screening criteria. The Delevan Pipeline Intake Facilities or Discharge Facility shall be designed to minimize hydraulic and physical habitat that is suitable for non-native predatory fish species. The facility shall be designed in coordination with NMFS and CDFG to ensure incorporation of the best available scientific and engineering knowledge of fish screen design to minimize predation potential on fish species of primary management concern. These design criteria shall minimize or avoid increased habitat suitability for non-native predatory fish species. However, a monitoring and adaptive management program shall be implemented to ensure that losses resulting from predatory fish are minimized.

Mitigation Measure Fish-1h: Prepare and Implement a Fish Salvage and Rescue Plan.

The fish screen at the Delevan Pipeline Intake Facilities shall be designed to comply with NMFS and CDFG fish screening criteria. In addition, a Fish Salvage and Rescue Plan shall be developed and

approved by NMFS and CDFG prior to initiation of construction activities, and could include the following measure:

- A qualified biologist shall provide construction monitoring throughout all phases of the project. If spawning activities for sensitive fish species are encountered during construction activities, the monitoring biologist shall be authorized to stop construction activities until appropriate corrective measures are completed or it is determined that the fish would not be harmed. If possible, all fish species shall be allowed to independently move away from the area. Fish that become entrapped in any side channel where construction work is taking place shall be netted, transported to the river, and released according to the Fish Salvage and Release Plan.

Implementation of **Mitigation Measures Fish-1a, Fish-1b, Fish-1c, Fish-1d, Fish-1e, Fish-1f, Fish-1g, and Fish-1f** would reduce the level of significance of Project impacts to aquatic biological resources to **less than significant**.

12.5 References

Armor, C., R. Baxter, B. Bennett, R. Bruer, M. Chotkowski, P. Coulston, D. Denton, B. Herbold, W. Kimmerer, K. Larsen, M. Nobirga, K. Rose, T. Sommer, and M. Stacey. 2005. Interagency Ecological Program synthesis of 2005 work to evaluate the Pelagic Organism Decline (POD) in the Upper San Francisco Estuary. Interagency Ecological Program, Sacramento, California. 55 pp

Baxter, R., R. Breuer, L. Brown, L. Conrad, F. Feyrer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, P. Hrodey, A. Mueller-Solger, T. Sommer, and K. Souza. 2010. 2010 Pelagic Organism Decline Work Plan and Synthesis of Results. Interagency Ecological Program for the San Francisco Estuary. December.

Baxter, R.D. 1999b. Splittail abundance and distribution update. Available at: http://www.dfg.ca.gov/delta/reports/splittail/

Bennett W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. San Francisco Estuary and Watershed Science 3(2):Article 1.

Birtwell, I. K., G. F. Hartman, B. Anderson, D. J. McLeay, and J. G. Malick. 1984. A Brief Investigation of Arctic Grayling (Thymallus arcticus) and Aquatic Invertebrates in the Minto Creek Drainage, Mayo, Yukon Territory: An Area Subjected to Placer Mining. Canadian Technical Report of Fisheries and Aquatic Sciences Volume 1287.

Bjornn T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19: 83–138.

Brown, C.J. 2000. North of the Delta Offstream Storage Investigation Progress Report. Appendix D: Fish Survey Summary. Assisted by W. Yip, G. Gorden, G. Low and A. Scholzen. CALFED Bay-Delta Program.

CALFED Bay-Delta Program (CALFED). 2000. CALFED Bay-Delta Program Environmental Impact Report/Environmental Impact Statement Record of Decision. CALFED Bay-Delta Program, Sacramento, California.

California Department of Fish and Game (CDFG). 2011a. State and federally listed endangered and threatened animals of California. January 2011. Department of Fish and Game, Bioeographic Data Branch, California Natural Diversity Database. Available: http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf. Accessed February 2011

California Department of Fish and Game (CDFG). 2011b. Grand Tab, California Central Valley Sacramento and San Joaquin River Systems Chinook salmon escapement hatcheries and natural areas. February 1, 2011. California Department of Fish and Game, Fisheries Branch, Anadromous Resource Assessment, Sacramento, California.

California Department of Fish and Game (CDFG). 2011c. Assessment of juvenile salmonid emigration monitoring on the lower Sacramento River. Unpublished data.

California Department of Fish and Game. 2010. Salvage Monitoring – Salvage/Export Data for the SWP and CVP fish facilities. Accessed at http://www.dfg.ca.gov/delta/apps/salvage.

California Department of Fish and Game (CDFG). 2009. California Natural Diversity Database website. Available at: http://www.dfg.ca.gov/biogeodata/cnddb/. Accessed December 2009.

California Department of Fish and Game (CDFG). 2003. Fisheries studies at Stony Creek, Thomes Creek, Sites Newville Projects, and Colusa Basin drain report. California Department of Fish and Game, Central Valley Bay-Delta Branch. 106 pp.

California Department of Water Resources (DWR). 2011. California Data Exchange Center. Provisional surface water data. Available at: http://cdec.water.ca.gov. Accessed February 2011.

California Department of Water Resources (DWR). 2009. California Water Plan Update 2009. San Francisco Bay, Volume 3 Regional Reports. Bulletin 160-09.

California Department of Water Resources (DWR). 2007. Oroville Facilities Relicensing FERC Project No. 2100 Draft Environmental Impact Report. California Department of Water Resources. Available at: http://www.water.ca.gov/orovillerelicensing/DEIR_070521.cfm. Accessed June 2010.

California Department of Water Resources (DWR). 2004a. Fish Species Composition and and Evaluation of Juvenile Bass Recruitment in the Thermalito Afterbay. Oroville Facilities Relicensing FERC Project No. 2100. SP-F3.1 Task 4A Final Report. California Department of Water Resources, Sacramento, California. 31 pp.

California Department of Water Resources (DWR). 2004b. Distribution and habitat use of juvenile steelhead and other fishes of the Lower Feather River. Oroville Facilities Relicensing FERC Project No. 2100. SP F-103A Final Report. California Department of Water Resources, Sacramento, California. 60 pp.

California Department of Water Resources (DWR). 2002. Evaluation of Lake Oroville water surface elevation reduction on bass (*Micropterus spp.*) spawning success. Oroville FERC Relicensing (Project No. 2100), Interim Progress Report, SP-F3, Task 2C. 10 pp.

California Department of Water Resources (DWR). 1994. Use of alternative gravel sources for fishery restoration and riparian habitat enhancement in Shasta and Tehama Counties, California. Department of Water Resources, Northern District, Red Bluff, California. 294 pp.

California Department of Water Resources (DWR). 1983. Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife.

California Department of Water Resources (DWR). 1980. Upper Sacramento River spawning gravel study. Department of Water Resources, Northern District, Red Bluff, California. 166 pp.

California Department of Water Resources (DWR). 1974. California high water 1973-1974. November 1974. California Department of Water Resources, Division of Resource Development, Sacramento, California. Bulletin No. 69-74. 67 pp

California Department of Water Resources and California Department of Fish and Game (DWR and CDFG). 2007. Pelagic Fish Action Plan. Sacramento, California. 84 pp.

DeVore, P. W., L. T. Brooke, and W. A. Swenson. 1980. The Effects of Red Clay Turbidity and Sedimentation on Aquatic Life in the Nemadji River System. Red Clay Project, Final Report, Part II. Prepared for U.S. Environmental Protection Agency, Great Lakes National Program Office. Impact of Nonpoint Pollution Control on Western Lake Superior. Washington, D.C.: U.S. EPA.

Federal Register. 2005. Endangered and threatened species: proposed rule to list the Southern DPS of the North American green sturgeon as threatened. 70FR17386.

Feyrer F., K. Newman, M. Nobriga, T. Sommer. 2010. Modeling the Effects of Future Outlfow and the Abiotic Habitat of an Imperiled Estuarine Fish. Coastal and Estuarine Research Federation (outside of USA).

Feyrer, F., M.L. Nobriga, and T.R. Sommer. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco estuary, California, U.S.A. Canadian Journal of Fish and Aquatic Science 64:723-734.

Grimaldo, L. F., T. Sommer, N. Van Ark, G. Jones, E. Holland, P.B. Moyle, B. Herbold, and P. Smith. 2009. Factors affecting fish entrainment into massive water diversions in a tidal freshwater estuary: can fish losses be managed? North American Journal of Fisheries Management 29: 1253-1270.

Hannon, J. Fisheries Biologist. U.S. Bureau of Reclamation (Reclamation). 2012. Personal communication with California Department of Water Resources NODOS Project Management Team on September 6.

Hedgecock D, M.A. Banks, V.K. Rashbrook, C.A. Dean, S.M. Blankenship. 2001. Applications of population genetics to conservation of Chinook salmon diversity in the Central Valley. Contributions to the biology of Central Valley salmonids. California Department of Fish and Game Fish Bulletin 179(1):45-70.

Herren, J. R., S. Kawasaki. 2001. *Inventory of Water Diversions in Four Geographic Areas in California's Central Valley*. Pages 343-355 in R. L. Brown, ed., Contributions to the Biology of Central Valley Salmonids. Volume 2. California Fish and Game. Fish Bulletin 179

Kimmerer, W. 2004. Open water processes of the San Francisco Estuary: from physical forcing to biological responses. San Francisco Estuary and Watershed Science. 2(1):Article 1.

Lloyd, D. S. 1987. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management. Volume 7: 34-45.

Moyle, P.B. 2008. The future of fish in response to large-scale change in the San Francisco Estuary, California. Pages 357-374 in K.D. McLaughlin, editor. *Mitigating impacts of natural hazards on fishery ecosystems*. American Fisheries Society, Symposium 64, Bethesda, Maryland.

Moyle, P.B. 2002. Inland fishes of California; revised and expanded. University of California Press. Berkeley, California.

Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish species of special concern in California, 2nd edition. California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. 277 pp.

Moyle, P.B., J.J. Smith, R.A. Daniels, and D.M. Baltz. 1982. Distribution and ecology of stream fishes of the Sacramento-San Joaquin Drainage System, California: a review. University California Publication, Zoology 115:225-256.

National Marine Fisheries Service (NMFS). 2011. Essential Fish Habitat. National Marine Fisheries Service Southwest Regional Office Website. Accessed March 2011 http://www.westcoast.fisheries.noaa.gov/habitat/fish_habitat/efh_consultations_go.html

National Marine Fisheries Service (NMFS). 2009. Biological Opinion on the long-term operations of the Central Valley Project and State Water Project Operations Criteria and Plan. National Marine Fisheries Service, Southwest Region, Long Beach, California. June 4, 2009. 844 pp.

National Marine Fisheries Service (NMFS). 1999. ESA salmon listing maps. National Marine Fisheries Service, Northwest Regional Office. Available at: http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Maps/Index.cfm. Accessed March 2011.

National Marine Fisheries Service (NMFS). 1997. NMFS proposed recovery plan for the Sacramento River winter-run Chinook salmon. National Marine Fisheries Service, Southwest Region. Long Beach California. 316 pp.

National Weather Service (NWS). 2011. National Oceanic and Atmospheric Administration, National Weather Service, California Nevada River Forecast Center Website. Accessed March 2011. www.cnrfc.noaa.gov.

Newcombe, C. P. and D. D. MacDonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems. North American Journal of Fisheries Management. Volume 11: 72-82.

Nichols, F., J. Cloern, S. Luoma, and D. Peterson. 1986. The Modification of an Estuary. Science 231: 567-573.

North State Resources. 2010. Sacramento River spawning gavel restoration and monitoring program. Gravel restoration and survey data.

Pacific Fishery Management Council (PFMC). 2003. Pacific coast salmon plan, fishery management plan for commercial and recreational salmon fisheries off the coast of Washington, Oregon, and California. Pacific Fishery Management Council, Portland, Oregon. September 2003. 78 pp.

Poytress, W.R., J.J. Gruber, D.A. Van Eenennam. 2011. 2011 Upper Sacramento River green sturgeon spawning habitat and larval migration surveys. Annual Report of U.S. Fish and Wildlife Service to U.S. Bureau of Reclamation, Red Bluff, California.

Poytress, W.R., J.J. Gruber, D.A. Trachtenbarg, and J.P. Van Eenennam. 2009. Upper Sacramento River green sturgeon spawning habitat and larval migration surveys. Annual Report of U.S. Fish and Wildlife Service to U.S. Bureau of Reclamation, Red Bluff, California.

Redding, J. M., C. B. Schreck, and F. H. Everest. 1987. Physiological Effects on Coho Salmon and Steelhead of Exposure to Suspended Solids. Transactions of the American Fisheries Society. Volume 116: 737-744.

Scannell, P. O. 1988. Effects of Elevated Sediment Levels From Placer Mining on Survival and Behavior of Immature Arctic Grayling. Master's Thesis. University of Alaska Fairbanks, Fairbanks, Alaska.

Servizi, J. A. and D. W. Martens. 1991. Effect of Temperature, Season, and Fish Size on Acute Lethality of Suspended Sediments to Coho Salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences. Volume 48: 493-497.

Sommer, T. R., M. L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001a. Floodplain rearing of juvenile Chinook salmon: Evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Science 58:325–333.

Sommer, T., D. McEwan, and G.H. Burgess. 2001b. Factors affecting Chinook salmon spawning in the Lower Feather River. Contributions to the biology of Central Valley salmonids. California Department of Fish and Game Fish Bulletin 179(1):269-297.

Surface Water Resources, Inc. (SWRI). 2004. Lower American River Flow Management Standard. Prepared for the Water Forum. Sacramento, CA.

Swenson, R.O., K. Whitener, and M. Eaton. 2001. Restoring floods on floodplains: riparian and floodplain restoration at the Cosumnes River Preserve. Pages 224-229. *In* P. M. Faber, editor. California riparian systems: processes and floodplain management, ecology, and restoration. 2001 riparian habitat and floodplains conference proceedings. Riparian Habitat Joint Venture, Sacramento, California.

Tehama Colusa Canal Authority and U.S. Bureau of Reclamation (TCCA and Reclamation), 2002. Fish Passage Improvement Project and the Red Bluff Diversion Dam Draft Environmental Impact Statement/Environmental Impact Report. August 2002. Tehama Colusa Canal Authority, Willows, California.

U.S. Bureau of Reclamation (Reclamation). 2008. Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project. August 2008. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California.

U.S. Bureau of Reclamation (Reclamation). 2001. Larval fish entrainment by Archimedes lifts and an internal helical pump at Red Bluff Research Pumping Plant, Upper Sacramento River, California. Red Bluff Research Pumping Plant Report Series, Volume 12. U.S. Bureau of Reclamation, Red Bluff, California. 14 pp.

U. S. Bureau of Reclamation (Reclamation). 1999a. Shasta Dam and Reservoir enlargement: appraisal assessment of the potential for enlarging Shasta Dam and Reservoir. May 1999. U.S. Bureau of Reclamation, Sacramento, California. 83 pp.

U.S. Bureau of Reclamation, Department of Water Resources, U.S. Fish and Wildlife Service, NOAA Fisheries, and Department of Fish and Game (Reclamation et al.) 2003. Environmental Water Account Draft Environmental Impact Statement/Environmental Impact Report. July 2003. U.S. Department of the Interior Bureau of Reclamation Mid-Pacific Region, Sacramento, California.

U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, California Department of Fish and Game, and Grassland Water District. 2001. Final NEPA environmental assessment and CEQA initial studies for the refuge water supply, long-term water supply agreements, San Joaquin River Basin. US Bureau of Reclamation, Mid-Pacific Region, Sacramento, California. 166 pp.

U.S. Fish and Wildlife Service (USFWS). 2010. Sacramento Fish and Wildlife Office. Endangered Species Program. Available at: http://www.fws.gov/sacramento/es/spp_list.htm. Accessed February 2011.

U.S. Fish and Wildlife Service (USFWS). 2008. Biological opinion for the long-term Central Valley project operations criteria and plan. U.S. Fish and Wildlife Service, California Nevada Region, Sacramento, California. 410 pp.

U.S. Fish and Wildlife Service (USFWS). 2004. Kern and pixley national wildlife refuges draft comprehensive conservation plan and environmental assessment. U.S. Fish and Wildlife Service, Region 1, Sacramento, California. 103 pp.

U.S. Fish and Wildlife Service (USFWS). 2000. Anadromous Fish Restoration Actions in the Butte Creek Watershed. Draft Programmatic Environmental Assessment. Prepared for the Sacramento-San Joaquin Estuary Fishery Resource Office, U.S. Fish and Wildlife Service. Prepared by Sacramento Fish and Wildlife Office. Sacramento, California.

Vogel, D. 2005. Biological evaluation of the fish screens at the Glenn-Colusa Irrigation District's Sacramento River pump station. 25 pp.

Water Forum. 2001. Initial fisheries and in-stream habitat management and restoration plan for the lower American River. October 31, 2001.

Werner, I.B., K.J. Elder, M. Clifford, J.P. Phillips, and R.P. Hedrick. 2006. An overview of the effects of pyrethroid insecticides on fish. *In* 4th Biennial CALFED Science Conference 2006.

Tables

Table 12-13

Summary of Potential Impacts: No Project/No Action Alternative Compared to Existing Conditions for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS

COMPARISON:

NO PROJECT/ NO ACTION ALTERNATIVE RELATIVE TO EXISTING CONDITIONS

	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
OPERATIONS IMPACTS		
Extended Study Area		
San Luis Reservoir	○	○
Export Service Area Reservoirs	◉	◉
Secondary Study Area		
Trinity Lake	◉	○
Shasta Lake	○	○
Lake Oroville	◉	○
Folsom Lake	◉	○

◉ SIMILAR / MORE SUITABLE ○ SIMILAR

◉ SIMILAR / LESS SUITABLE

Table 12-14
Summary of Potential Impacts: No Project/No Action Alternative Compared to Existing Conditions for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

This document is not released as a draft EIR pursuant to CEQA Guidelines § 15087. As such, DWR is not soliciting and will not respond to comments submitted on this document, although any comments received will be retained and may be considered during preparation of a future draft EIR.

NODOS FISHERIES SYNTHESIS

COMPARISON: NO PROJECT/ NO ACTION ALTERNATIVE RELATIVE TO EXISTING CONDITIONS

	Coho Salmon SOUTHERN OREGON / NORTHERN CALIFORNIA	Chinook Salmon UPPER KLAMATH - TRINITY	Steelhead KLAMATH MOUNTAINS PROVINCE	Chinook Salmon SACRAMENTO RIVER WINTER-RUN	Chinook Salmon CENTRAL VALLEY SPRING-RUN	Chinook Salmon CENTRAL VALLEY FALL-RUN	Chinook Salmon CENTRAL VALLEY LATE FALL-RUN	Steelhead CENTRAL VALLEY	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	○	○	○						○	○	○									
Sacramento River				◉	○	○	○	○	○	○	○	○	○	○				○	○	○
Clear Creek					◉	◉	◉	◉			◉	◉	◉	◉						
Feather River					○	○		○	○	○	○	○	○	○			○	○	○	○
American River					○	●		●	●		●	●	◉	◉			●	●	●	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	○	○	○							○			○
Delta				○	○	○	○	○	○	○	○	○			○	○	○	○	○	○
Bays[+]				○	○	○	○	○	○	○	○	○			○	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

• Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

✚ Includes Suisun, San Pablo, and San Francisco Bays

◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◉ SIMILAR / LESS SUITABLE ● LESS SUITABLE

Table 12-15

Summary of Potential Impacts: Alternative A Compared to Existing Conditions for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS

COMPARISON:

ALTERNATIVE A RELATIVE TO EXISTING CONDITIONS

	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
OPERATIONS IMPACTS		
Extended Study Area		
San Luis Reservoir	◉	◉
Export Service Area Reservoirs	●	●
Secondary Study Area		
Trinity Lake	●	◉
Shasta Lake	●	◉
Lake Oroville	○	○
Folsom Lake	●	◉

◉ SIMILAR / MORE SUITABLE

◉ SIMILAR / LESS SUITABLE

● MORE SUITABLE

○ SIMILAR

Table 12-16
Summary of Potential Impacts: Alternative A Compared to Existing Conditions for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE A RELATIVE TO EXISTING CONDITIONS

	Coho Salmon SOUTHERN OREGON / NORTHERN CALIFORNIA	Chinook Salmon UPPER KLAMATH - TRINITY	Steelhead KLAMATH MOUNTAINS PROVINCE	Chinook Salmon SACRAMENTO RIVER WINTER-RUN	Chinook Salmon CENTRAL VALLEY SPRING-RUN	Chinook Salmon CENTRAL VALLEY FALL-RUN	Chinook Salmon CENTRAL VALLEY LATE FALL-RUN	Steelhead CENTRAL VALLEY	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	○	◉	○						◉	○	○									
Sacramento River				●	●	◉	○	○	◉	◉	○	○	○	○				○	○	○
Clear Creek					◉	◉	◉	◉			◉	◉	◉	◉						
Feather River					◉	○		○	○	◉	◉	◉	◉	○			○	◉	◉	○
American River					◉	◉		◉	◉		◉	◉	○	○			◉	◉	◉	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	●	●	●							●			●
Delta				◉	◉	◉	◉	○	○	○	○	○			○	○	◉	○	○	◉
Bays[+]				○	○	○	○	○	○	○	○	○			○	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

● MORE SUITABLE ◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◉ SIMILAR / LESS SUITABLE ● LESS SUITABLE

• Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

✚ Includes Suisun, San Pablo, and San Francisco Bays

Table 12-17

Summary of Potential Impacts: Alternative A Compared to the No Project/No Action Alternative for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS

COMPARISON:
ALTERNATIVE A RELATIVE TO THE NO PROJECT/ NO ACTION ALTERNATIVE

	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
OPERATIONS IMPACTS		
Extended Study Area		
San Luis Reservoir	○	◉
Export Service Area Reservoirs	●	●
Secondary Study Area		
Trinity Lake	●	●
Shasta Lake	●	●
Lake Oroville	●	○
Folsom Lake	●	○

● SIMILAR / MORE SUITABLE
● MORE SUITABLE
◉ SIMILAR / LESS SUITABLE
○ SIMILAR

Table 12-18
Summary of Potential Impacts: Alternative A Compared to the No Project/No Action Alternative for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE A RELATIVE TO THE NO PROJECT/ NO ACTION ALTERNATIVE

	Coho Salmon (Southern Oregon / Northern California)	Chinook Salmon (Upper Klamath - Trinity)	Steelhead (Klamath Mountains Province)	Chinook Salmon (Sacramento River Winter-run)	Chinook Salmon (Central Valley Spring-run)	Chinook Salmon (Central Valley Fall-run)	Chinook Salmon (Central Valley Late Fall-run)	Steelhead (Central Valley)	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	◉	◉	○						◉	○	○									
Sacramento River				●	●	○	○	○	◉	○	○	○	○	○				○	○	○
Clear Creek					◉	◉	○	○			○	○	○	○						
Feather River					○	○		○	○	◉	◉	◉	◉	○			◉	◉	◉	○
American River					○	◉		○	◉		●	●	◉	◉			◉	●	●	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	●	●	●							●			●
Delta				○	○	○	○	○	○	○	○	○			◉	○	◉	○	○	○
Bays+				○	○	○	○	○	○	○	○	○			◉	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

- Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

+ Includes Suisun, San Pablo, and San Francisco Bays

● MORE SUITABLE ◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◉ SIMILAR / LESS SUITABLE ● LESS SUITABLE

Table 12-19

Summary of Potential Impacts: Alternative B Compared to Existing Conditions for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE B RELATIVE TO EXISTING CONDITIONS

	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
OPERATIONS IMPACTS		
Extended Study Area		
San Luis Reservoir	SIMILAR / LESS SUITABLE	SIMILAR / LESS SUITABLE
Export Service Area Reservoirs	MORE SUITABLE	MORE SUITABLE
Secondary Study Area		
Trinity Lake	MORE SUITABLE	SIMILAR / MORE SUITABLE
Shasta Lake	MORE SUITABLE	SIMILAR / MORE SUITABLE
Lake Oroville	SIMILAR / MORE SUITABLE	SIMILAR
Folsom Lake	SIMILAR	SIMILAR

SIMILAR / MORE SUITABLE — MORE SUITABLE

SIMILAR / LESS SUITABLE — SIMILAR

Table 12-20
Summary of Potential Impacts: Alternative B Compared to the Existing Conditions for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE B RELATIVE TO EXISTING CONDITIONS

	Coho Salmon SOUTHERN OREGON / NORTHERN CALIFORNIA	Chinook Salmon UPPER KLAMATH - TRINITY	Steelhead KLAMATH MOUNTAINS PROVINCE	Chinook Salmon SACRAMENTO RIVER WINTER-RUN	Chinook Salmon CENTRAL VALLEY SPRING-RUN	Chinook Salmon CENTRAL VALLEY FALL-RUN	Chinook Salmon CENTRAL VALLEY LATE FALL-RUN	Steelhead CENTRAL VALLEY	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	○	◉	○						○	○	○									
Sacramento River				●	●	○	○	○	◉	◎	○	○	○	○				○	○	○
Clear Creek					◉	◉	◉	◉			◉	◉	◉	◉						
Feather River					◉	○		○	○	◎	◎	◎	◎	◎			◎	◎	◎	○
American River					◎	◎		◎	◎		◎	◎	○	○			◎	◎	◎	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	●	●	●							●			●
Delta				◉	◉	◉	◉	○	○	○	○	○			○	○	◎	○	○	○
Bays+				○	○	○	○	○	○	○	○	○			○	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

- Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

+ Includes Suisun, San Pablo, and San Francisco Bays

● MORE SUITABLE ◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◎ SIMILAR / LESS SUITABLE ● LESS SUITABLE

Table 12-21

Summary of Potential Impacts: Alternative B Compared to the No Project/No Action Alternative for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE B RELATIVE TO THE NO PROJECT/ NO ACTION ALTERNATIVE

	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
OPERATIONS IMPACTS		
Extended Study Area		
San Luis Reservoir	●	○
Export Service Area Reservoirs	●	●
Secondary Study Area		
Trinity Lake	●	◉
Shasta Lake	●	◉
Lake Oroville	●	○
Folsom Lake	●	○

◉ SIMILAR / MORE SUITABLE ● MORE SUITABLE

○ SIMILAR

Table 12-22
Summary of Potential Impacts: Alternative B Compared to the No Project/No Action Alternative
for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE B RELATIVE TO THE NO PROJECT/ NO ACTION ALTERNATIVE

	Coho Salmon SOUTHERN OREGON / NORTHERN CALIFORNIA	Chinook Salmon UPPER KLAMATH - TRINITY	Steelhead KLAMATH MOUNTAINS PROVINCE	Chinook Salmon SACRAMENTO RIVER WINTER-RUN	Chinook Salmon CENTRAL VALLEY SPRING-RUN	Chinook Salmon CENTRAL VALLEY FALL-RUN	Chinook Salmon CENTRAL VALLEY LATE FALL-RUN	Steelhead CENTRAL VALLEY	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	○	○	○						○	○	○									
Sacramento River				●	◉	○	○	○	◉	○	○	○	○	○				○	○	○
Clear Creek					◉	◉	○	○			○	○	○	○						
Feather River					○	○		○	○	◉	◉	◉	◉	○			◉	○	○	○
American River					○	◉		◉	○		◉	◉	◉	◉			○	◉	◉	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	●	●	●							●			●
Delta				○	○	○	○	○	○	○	○	○			◉	○	◉	○	○	○
Bays+				○	○	○	○	○	○	○	○	○			◉	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

- Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

+ Includes Suisun, San Pablo, and San Francisco Bays

● MORE SUITABLE ◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◉ SIMILAR / LESS SUITABLE ● LESS SUITABLE

Table 12-23

Summary of Potential Impacts: Alternative C Compared to Existing Conditions for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS

COMPARISON:
ALTERNATIVE C RELATIVE TO EXISTING CONDITIONS

OPERATIONS IMPACTS	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
Extended Study Area		
San Luis Reservoir	SIMILAR / LESS SUITABLE	SIMILAR / LESS SUITABLE
Export Service Area Reservoirs	MORE SUITABLE	MORE SUITABLE
Secondary Study Area		
Trinity Lake	MORE SUITABLE	SIMILAR / MORE SUITABLE
Shasta Lake	MORE SUITABLE	MORE SUITABLE
Lake Oroville	SIMILAR	SIMILAR
Folsom Lake	SIMILAR / MORE SUITABLE	SIMILAR / LESS SUITABLE

SIMILAR / MORE SUITABLE
MORE SUITABLE
SIMILAR / LESS SUITABLE
SIMILAR

Table 12-24
Summary of Potential Impacts: Alternative C Compared to Existing Conditions for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE C RELATIVE TO EXISTING CONDITIONS

	Coho Salmon SOUTHERN OREGON / NORTHERN CALIFORNIA	Chinook Salmon UPPER KLAMATH - TRINITY	Steelhead KLAMATH MOUNTAINS PROVINCE	Chinook Salmon SACRAMENTO RIVER WINTER-RUN	Chinook Salmon CENTRAL VALLEY SPRING-RUN	Chinook Salmon CENTRAL VALLEY FALL-RUN	Chinook Salmon CENTRAL VALLEY LATE FALL-RUN	Steelhead CENTRAL VALLEY	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	○	◉	○						◉	○	○									
Sacramento River				●	◉	○	○	○	◉	◉	○	○	○	○				○	○	○
Clear Creek					◉	◉	◉	◉			◉	◉	◉	◉						
Feather River					◉	○		○	○	◉	◉	◉	◉	○			◉	◉	◉	○
American River					◉	◉		◉	◉		◉	◉	○	○			◉	◉	◉	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	●	●	●							●			●
Delta				○	○	◉	◉	○	○	○	○	○			○	○	◉	○	○	◉
Bays[+]				○	○	○	○	○	○	○	○	○			○	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

- Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

+ Includes Suisun, San Pablo, and San Francisco Bays

● MORE SUITABLE ◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◉ SIMILAR / LESS SUITABLE ● LESS SUITABLE

Table 12-25

Summary of Potential Impacts: Alternative C Compared to the No Project/No Action Alternative for Fish Species of Primary Management Concern that use Reservoir Habitat

NODOS FISHERIES SYNTHESIS COMPARISON: ALTERNATIVE C RELATIVE TO THE NO PROJECT/ NO ACTION ALTERNATIVE	Reservoir Coldwater FISH SPECIES	Reservoir Warmwater FISH SPECIES
OPERATIONS IMPACTS		
Extended Study Area		
San Luis Reservoir	LESS SUITABLE	SIMILAR / LESS SUITABLE
Export Service Area Reservoirs	MORE SUITABLE	MORE SUITABLE
Secondary Study Area		
Trinity Lake	MORE SUITABLE	SIMILAR / MORE SUITABLE
Shasta Lake	MORE SUITABLE	SIMILAR / MORE SUITABLE
Lake Oroville	SIMILAR / MORE SUITABLE	SIMILAR
Folsom Lake	MORE SUITABLE	SIMILAR

SIMILAR / MORE SUITABLE

SIMILAR / LESS SUITABLE

LESS SUITABLE

MORE SUITABLE

SIMILAR

Table 12-26
Summary of Potential Impacts: Alternative C Compared to the No Project/No Action Alternative for Fish Species of Primary Management Concern that use Riverine, Estuarine, and Floodplain Habitats

NODOS FISHERIES SYNTHESIS

COMPARISON: ALTERNATIVE C RELATIVE TO THE NO PROJECT/ NO ACTION ALTERNATIVE

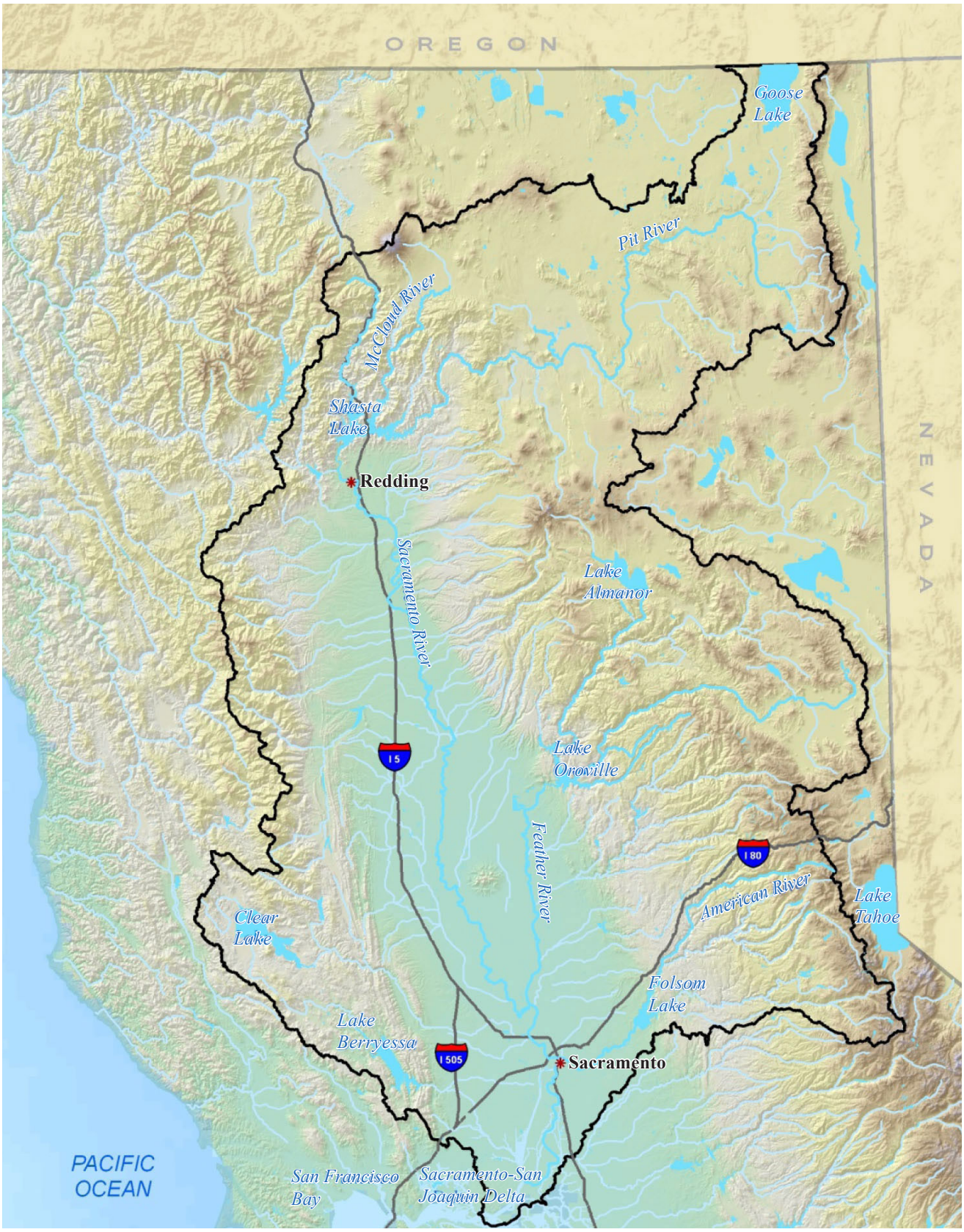
	Coho Salmon SOUTHERN OREGON / NORTHERN CALIFORNIA	Chinook Salmon UPPER KLAMATH - TRINITY	Steelhead KLAMATH MOUNTAINS PROVINCE	Chinook Salmon SACRAMENTO RIVER WINTER-RUN	Chinook Salmon CENTRAL VALLEY SPRING-RUN	Chinook Salmon CENTRAL VALLEY FALL-RUN	Chinook Salmon CENTRAL VALLEY LATE FALL-RUN	Steelhead CENTRAL VALLEY	Green Sturgeon	White Sturgeon	Pacific Lamprey	River Lamprey	Hardhead	Roach	Delta Smelt	Longfin Smelt	Splittail	Striped Bass	American Shad	Largemouth Bass
OPERATIONS IMPACTS																				
Extended Study Area																				
Wildlife Refuges														○			○			
Secondary Study Area																				
Trinity River	◉	◉	○						○	○	○									
Sacramento River				●	◉	○	○	○	◉	○	○	○	○	○				○	○	○
Clear Creek					◉	◉	○	○			○	○	○	○						
Feather River					○	○		○	○	◉	◉	◉	◉	○			○	◉	◉	○
American River					◉	●		◉	◉		●	●	◉	◉			○	◉	◉	○
Sutter Bypass				○	○	○	○	○	○	○							○			
Yolo Bypass				•	•	•	•	●	●	●							●			●
Delta				○	○	○	○	○	○	○	○	○			◉	○	◉	○	○	○
Bays+				○	○	○	○	○	○	○	○	○			◉	○		○	○	
Primary Study Area																				
Funks & Stone Corral Creeks														○						

- Changes in juvenile Chinook salmon survival through the Delta (including the Yolo Bypass) are simulated in the Delta Passage Model, and are included within the Delta evaluation.

+ Includes Suisun, San Pablo, and San Francisco Bays

● MORE SUITABLE ◉ SIMILAR / MORE SUITABLE ○ SIMILAR ◉ SIMILAR / LESS SUITABLE ● LESS SUITABLE

Figures



N

0 20 40 60 80 Miles

FIGURE 12-1
Sacramento River Watershed
North-of-the-Delta Offstream Storage Project

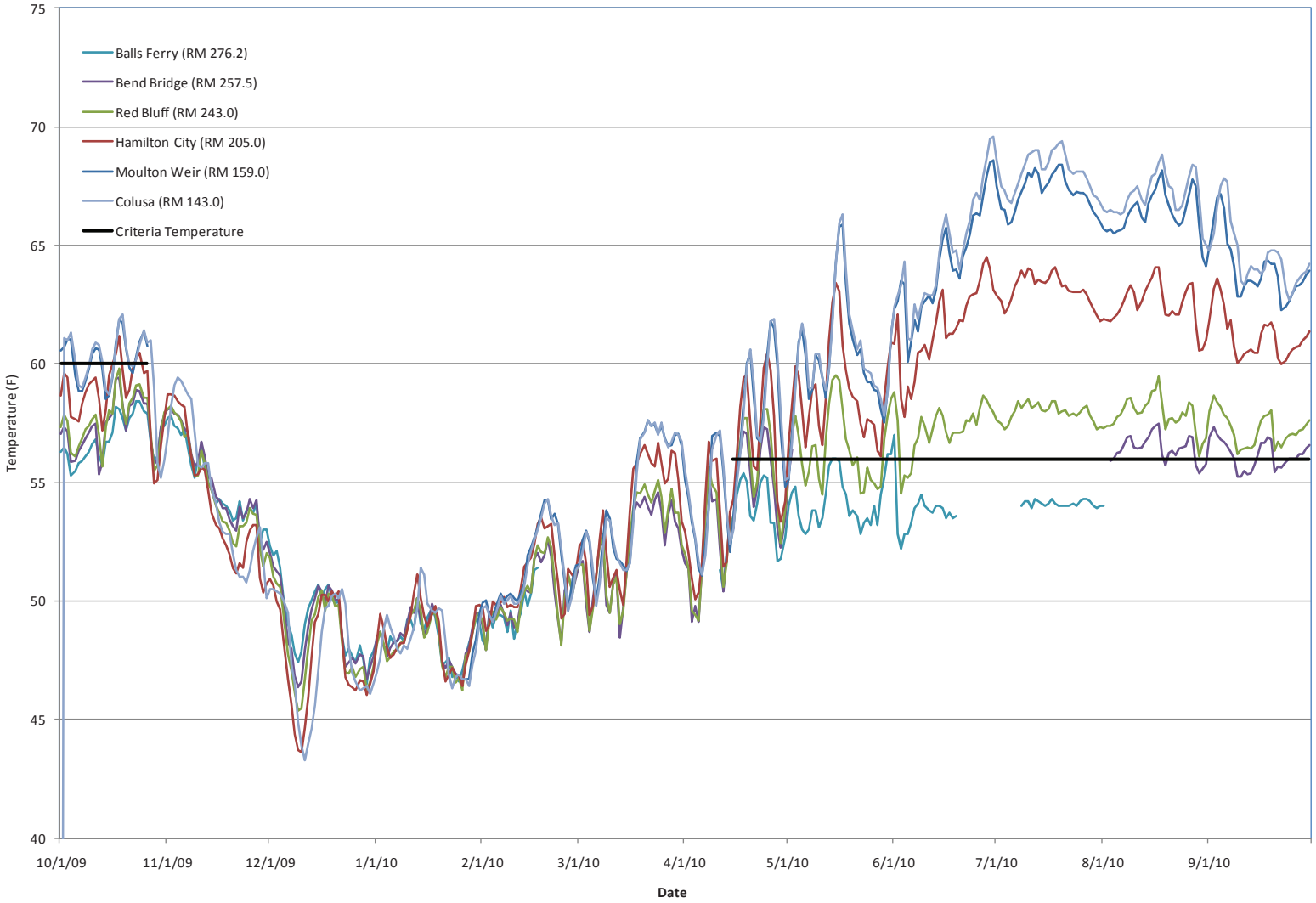


FIGURE 12-2
Average Daily Water Temperatures for the Sacramento River from Balls Ferry (RM 276) to Colusa (RM 143) during Water Year 2010
North-of-the-Delta Offstream Storage Project

Note: RM - River Mile

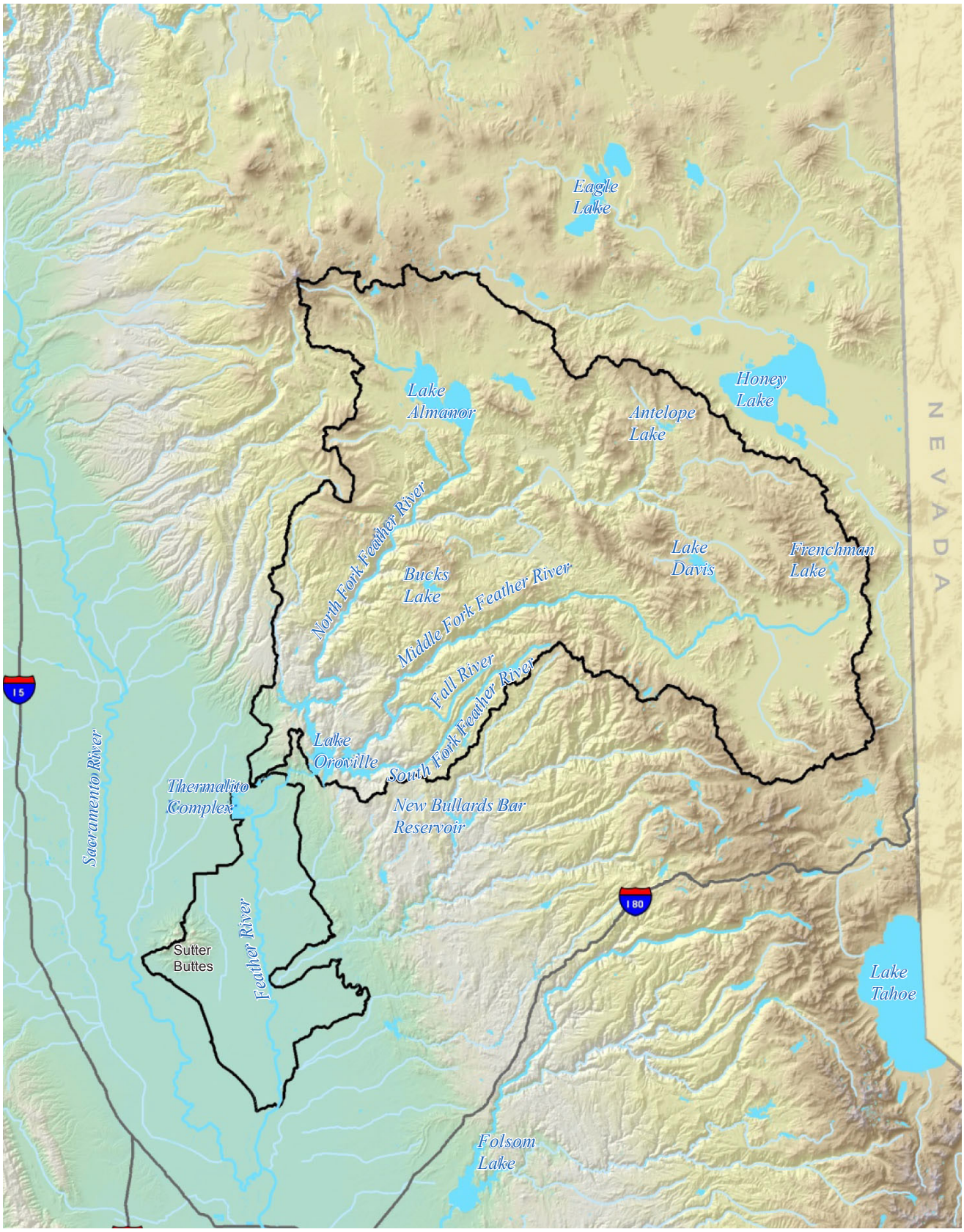
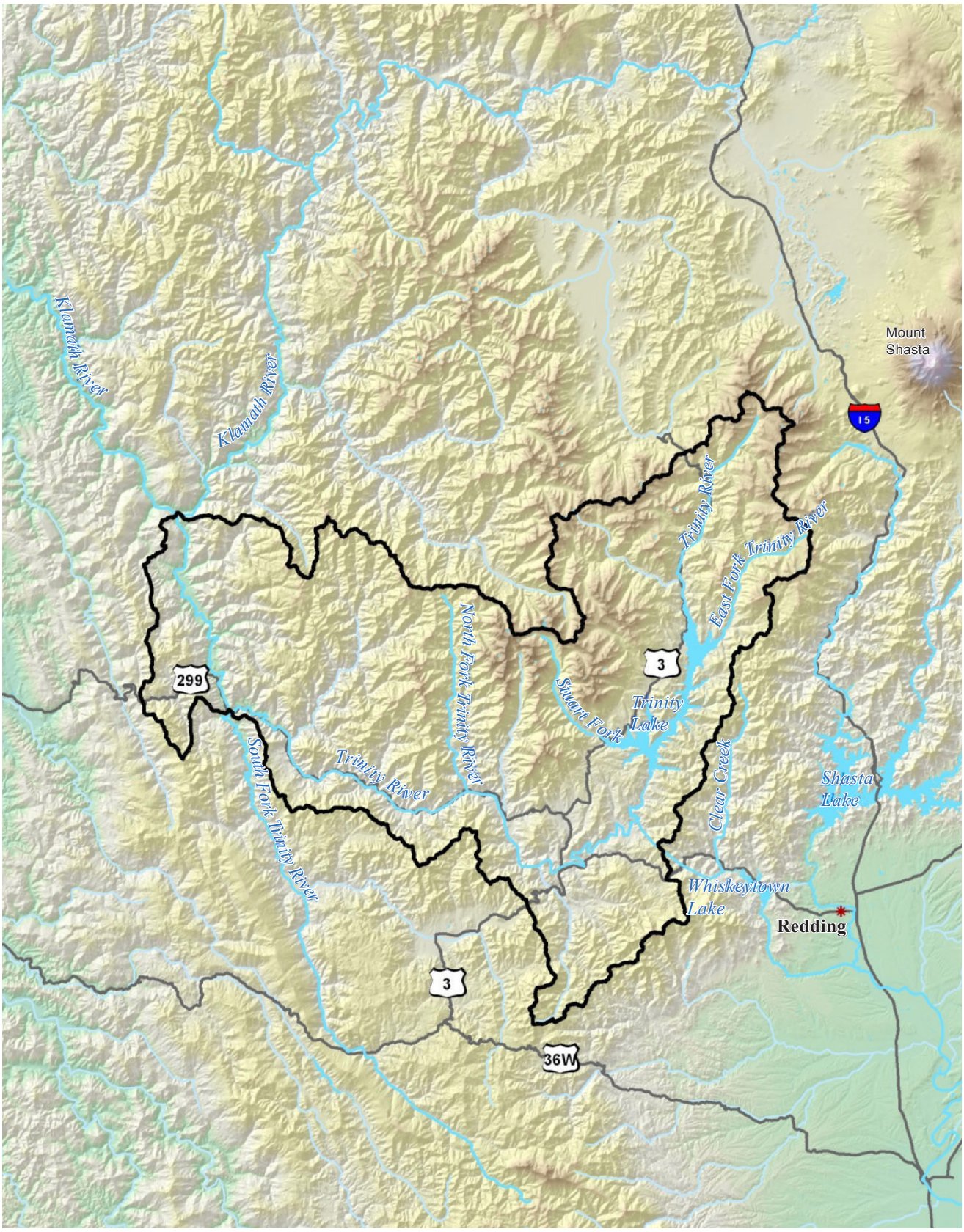


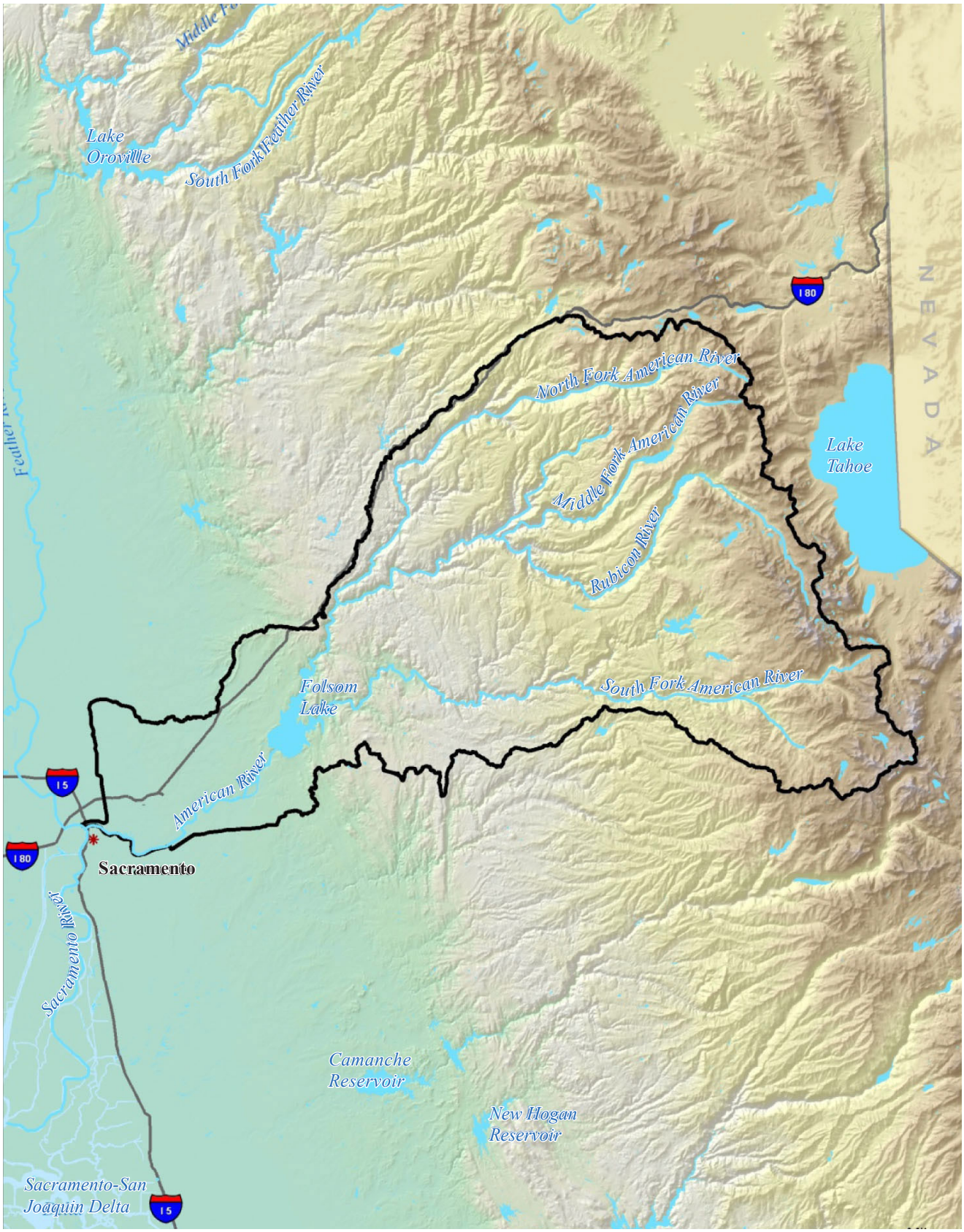
FIGURE 12-3
Feather River Watershed
North-of-the-Delta Offstream Storage Project



N

0 10 20 30 40 Miles

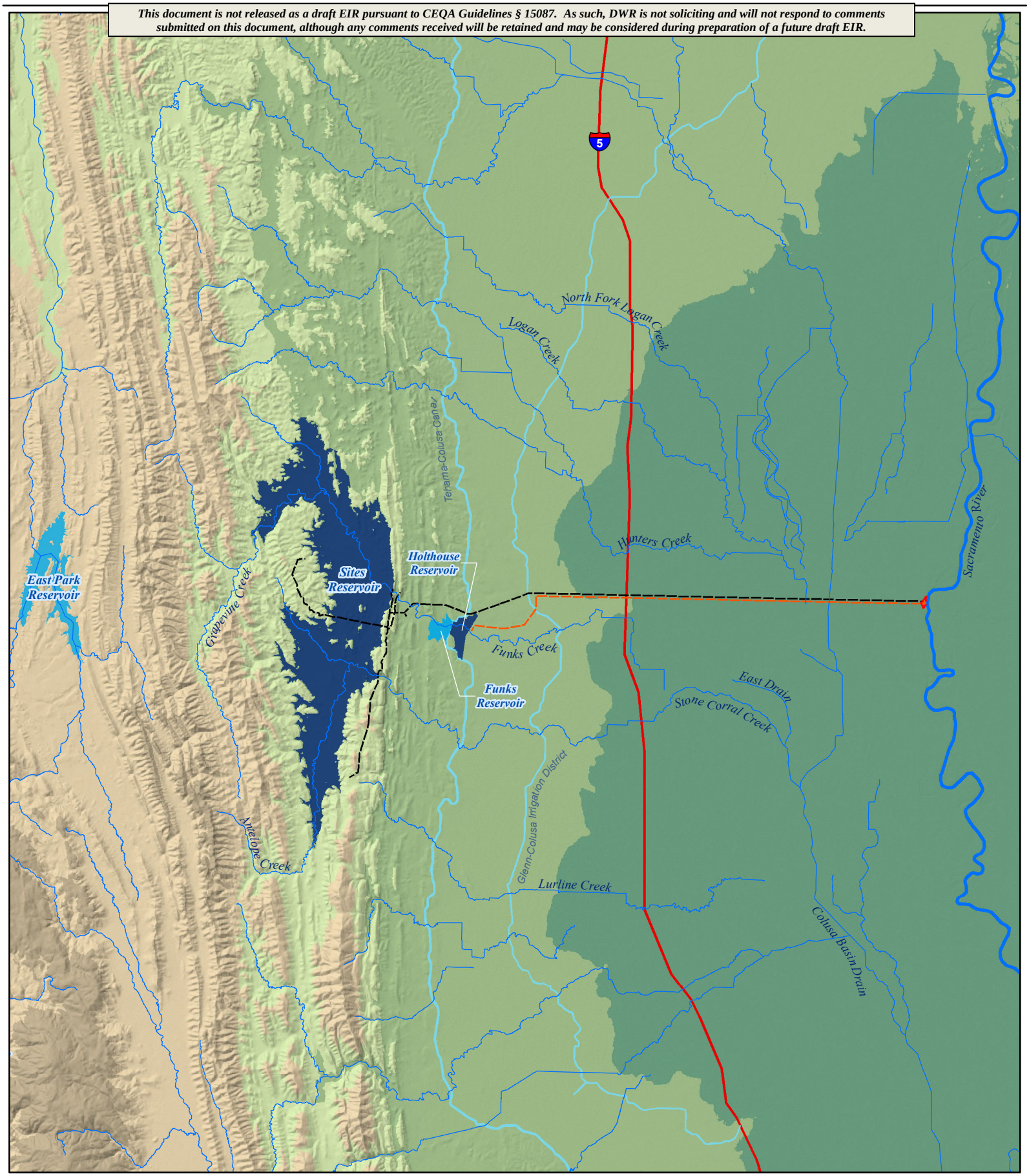
FIGURE 12-4
Trinity River Watershed
North-of-the-Delta Offstream Storage Project



N

0 10 20 30 40 Miles

FIGURE 12-5
American River Watershed
North-of-the-Delta Offstream Storage Project



Legend

- Stream or River
- Existing Reservoir
- Proposed Delevan Pipeline Intake Facilities
- Proposed Delevan Transmission Line
- Proposed Delevan Pipeline
- Proposed Reservoir
- Canal

FIGURE 12-6
Waterways Within the Primary Study Area

North-of-the-Delta Offstream Storage Project

N

0 1 2 4 6 8 10 mi

Path: W:\NODOS\MapFiles\Chapters\Fisheries\Figure12-6_Waterways_New.mxd

Stone Corral Creek within the Proposed Sites Reservoir Footprint in the Town of Sites (2/23/2011)

Stone Corral Creek Immediately Downstream of the Proposed Sites Dam Location (2/23/2011)

FIGURE 12-7
Proposed Project Facility Locations
North-of-the-Delta Offstream Storage Project

Stone Corral Creek Immediately Downstream of the Proposed Sites Dam Location (Looking Upstream) (2/23/2011)

Portion of Funks Creek that would be Inundated by the Proposed Holthouse Reservoir (Looking Downstream from Funks Dam) (2/23/2011)

FIGURE 12-8
Proposed Project Facility Locations
North-of-the-Delta Offstream Storage Project

Portion of Funks Creek that would be Inundated by the Proposed Holthouse Reservoir (Looking Downstream from Funks Dam) (2/23/2011)

Location of the Proposed Delevan Pipeline Intake Facilities on the Sacramento River (Looking Downstream from the Existing Maxwell Irrigation District Intake) (2/23/2011)

FIGURE 12-9
Proposed Project Facility Locations
North-of-the-Delta Offstream Storage Project

Location of the Proposed Delevan Pipeline Intake Facilities on the Sacramento River (Looking Downstream from the Existing Maxwell Irrigation District Intake) (2/23/2011)

FIGURE 12-10
Proposed Project Facility Locations
North-of-the-Delta Offstream Storage Project